



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: **U.S. Patent No. 5,654,301**  
Inventor: KOHN, Harold et al.  
Issue Date: August 5, 1997  
For: AMINO ACID DERIVATIVE ANTICONVULSANT  
Assignee: Research Corporation Technologies, Inc.  
Date: December 23, 2008  
Attorney Docket: 32555-0002-2  
NDA: **NDA 22-254 (VIMPAT® injection)**

**Mail Stop Hatch-Waxman PTE**  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**TRANSMITTAL FOR APPLICATION FOR EXTENSION OF PATENT**

Sir:

Transmitted herewith for filing is an Application For Extension of Patent Term Under 35 U.S.C. §156 with respect to the above-identified patent.

Applicant, the assignee of the above-referenced patent, on this day has filed simultaneously four related applications for extension of patent term under 35 U.S.C. §156, including the present application referenced in the header above. These four patent term extension applications relate to different combinations of U.S. Patent nos. Re38,551 and 5,654,301 and FDA approvals for New Drug Application nos. NDA 22-253 and NDA 22-254. The four patent term extension applications are summarized in the following table.

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U.S. Patent No. 5,654,301  
Transmittal Application for Extension of Patent

Attorney Docket No.	Patent No.	NDA No.	Approved Product
32555-0002-1	Re38,551	NDA22-253	VIMPAT® (lacosamide) tablet
32555-0002-2	5,654,301	NDA 22-254	VIMPAT® (lacosamide) injection
32555-0002-3	Re38,551	NDA 22-254	VIMPAT® (lacosamide) injection
32555-0002-4	5,654,301	NDA 22-253	VIMPAT® (lacosamide) tablet

Applicant asserts that it has the right, under 35 U.S.C. § 156, to extend two patents relating to VIMPAT® (lacosamide) because two NDAs, NDA 22-253 and NDA 22-254 for VIMPAT® (lacosamide) tablet and VIMPAT® (lacosamide) injection, respectively, were approved on the same day, namely October 28, 2008, and because there were no approvals of lacosamide that occurred prior to October 28, 2006. As such, Applicant has submitted the above four applications for patent term extension with the goal of ultimately obtaining one patent term extension for each of U.S. Patent nos. Re38,551 and 5,654,301.

Applicant respectfully requests that if the Commissioner determines that both of U.S. Patent nos. Re38,551 and 5,654,301 are entitled to a patent term extension under the same regulatory review period or periods (i.e., for the same NDA(s)), and/or determines that at least one of U.S. Patent nos. Re38,551 and 5,654,301 is entitled to a patent term extension under both regulatory review periods (i.e., for both of the two NDA approvals), that the Commissioner establish a time period in accord with the policies set forth in MPEP § 2761 within which the Applicant will be permitted to elect the patent and product combination(s) for which extension is desired and/or to voluntarily withdraw applications. At that time, Applicant will elect and withdraw applications for patent term extension, as appropriate, to ensure that only one patent is extended for each NDA, and such that a given patent obtains only one extension under 35 U.S.C. § 156.

U.S. Patent No. 5,654,301  
Transmittal Application for Extension of Patent

Applicant respectfully requests that if the Commissioner does not share Applicant's view that it is entitled under 35 U.S.C. § 156 to extend a different patent for each of the two above-identified simultaneously-approved NDAs, that the Commissioner direct the Office to contact the undersigned attorney.

In light of the above, and in accordance with the requirements of 35 U.S.C. § 156, attached for the patent and NDA approval identified in the above header are the following:

- 1) Application For Extension of Patent Term (including Exhibits A-F) – application 15 pages and Exhibits 155 pages for 170 pages total;
- 2) Extra copy 1 of Application for Extension of Patent Term (including Exhibits A-F) – application 15 pages and Exhibits 155 pages for 170 pages total; and
- 3) Extra copy 2 of Application for Extension of Patent Term (including Exhibits A-F) – application 15 pages and Exhibits 155 pages for 170 pages total.

Please charge my Deposit Account No. 50-1349 the amount of \$1,120.00, which is believed to be the appropriate fee for a patent term extension as established by 37 C.F.R. § 1.20(j),.

The Commissioner is hereby authorized to charge payment of any fees associated with or necessary for the prosecution of this patent term extension application, including debiting any deficit or crediting any overpayment relating to the fee identified above, to Deposit Account No. 50-1349.

Respectfully submitted,

**HOGAN & HARTSON LLP**

Dated: December 23, 2008

By: 

Kevin G. Shaw  
Registration No. 43,110

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**Customer No. 24633**



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: **U.S. Patent No. 5,654,301**  
Inventor: KOHN, Harold et al.  
Issue Date: August 5, 1997  
For: AMINO ACID DERIVATIVE ANTICONVULSANT  
Assignee: Research Corporation Technologies, Inc.  
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Attorney Docket: 32555-0002-2  
NDA: **NDA 22-254 (VIMPAT® injection)**

Mail Stop Hatch-Waxman PTE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

APPLICATION FOR EXTENSION OF PATENT  
TERM UNDER 35 U.S.C. §156

Commissioner for Patents:

Applicant, Research Corporation Technologies, Inc., a non-profit corporation organized and existing under the laws of Delaware, and having a principal place of business at 5210 E. Williams Circle, Suite 240, Tucson, Arizona 85711-4410, represents that it is the owner of the entire interest in and to U.S. Patent No. 5,654,301, granted to Harold Kohn and Darrell Watson for "Amino Acid Derivative Anticonvulsant," as reflected in the assignment document recorded by the U.S. Patent and Trademark Office on January 12, 1993 at Reel 006433, Frame 0347. Attached at **Exhibit A** is a Power of Attorney document appointing the undersigned patent attorney as legal representative of Applicant.

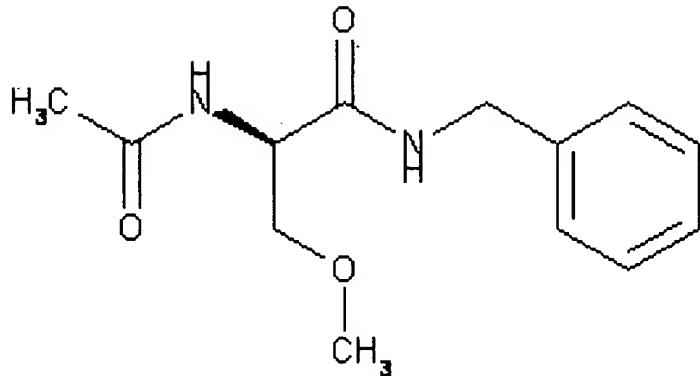
Schwarz Biosciences, Inc. ("Schwarz"), a corporation of the state of Delaware and having a place of business at 1209 Orange St., Wilmington, DE 19801, is the owner of a New Drug Application ("NDA") for VIMPAT® injection, NDA number NDA 22-254. Schwarz

Pharma AG (“SPAG”), having its registered office at Alfred-Nobel Strasse 10, 40789 Monheim, Germany, has exclusive license rights under U.S. Patent No. 5,654,301 to lacosamide, R-2-Acetamido-N-benzyl-3-methoxypropionamide. Schwarz and SPAG are related companies, being wholly owned by UCB S.A., which has its registered office at Allée de la Recherche 60, 1070 Brussels, Belgium. Attached at **Exhibit B** is a Letter of Reliance document granting to the Applicant from Schwarz the right to rely upon NDA 22-254 and the activities of SPAG and its predecessors in interest supporting FDA approval of VIMPAT® injection for purposes of obtaining any and all patent term extensions available in conjunction with the approval of VIMPAT® injection.

Applicant, acting through its duly authorized attorney, hereby submits this application for extension of patent term under 35 U.S.C. §156, based upon the approval by the Food and Drug Administration for commercial marketing or use of VIMPAT® injection, since the active ingredient of VIMPAT® injection is lacosamide and lacosamide falls within the ambit of the claims of U.S. Patent No. 5,654,301. The information contained in this Application and its Exhibits is provided in accordance with the rules promulgated by the U.S. Patent and Trademark Office at 37 CFR §§1.710-1.785 and presented in the manner set forth at 37 CFR §1.740.

1. A Complete Identification Of The Approved Product As By Appropriate Chemical And Generic Name, Physical Structure Or Characteristics

The approved product, VIMPAT® injection, contains lacosamide as its active ingredient and is indicated for adjunctive therapy in the treatment of partial-onset seizures in patients with epilepsy aged 17 years and older when oral administration is temporarily not feasible. The IUPAC chemical name of lacosamide is (R)-2-acetamido-N-benzyl-3-methoxypropionamide. Lacosamide has the empirical formula C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>, and has a molecular weight of 250.30. Lacosamide is present in VIMPAT® injection in the form of a single (R)-enantiomer, and has the structural formula:



Lacosamide is prepared as a white to light yellow powder that is sparingly soluble in acetonitrile and ethanol. The approved product is formulated for intravenous injection as a clear, colorless, sterile solution containing 10 mg lacosamide per mL for intravenous infusion. One 20 mL vial contains 200 mg of lacosamide, plus inactive ingredients sodium chloride and water for injection. Hydrochloric acid is used for pH adjustment, giving VIMPAT® injection a pH of 3.5 to 5.0. The initial recommended dosage regimen is 100 mg of lacosamide infusion per day, and dosage can be increased, such as at weekly intervals of 100 mg/day, until a maintenance dose of 200 to 400 mg/day (based upon individual patient response and tolerability) is reached.

2. A Complete Identification Of The Federal Statute Including The Applicable Provisions Of Law Under Which The Regulatory Review Occurred

The approved product, VIMPAT® injection, was subject to regulatory review under Section 505 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. §355).

3. An Identification Of The Date On Which The Product Received Permission For Commercial Marketing Or Use Under The Provision Of Law Under Which The Applicable Regulatory Review Period Occurred

The approved product, VIMPAT® injection, received permission for commercial marketing or use under Section 505 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. §355) on October 28, 2008. A copy of a letter from the Food and Drug Administration (“FDA”) indicating the date of approval is attached hereto at **Exhibit C**.

4. In The Case Of A Drug Product, An Identification Of Each Active Ingredient In The Product And As To Each Active Ingredient, A Statement That It Has Not Been Previously Approved For Commercial Marketing Or Use Under The Federal Food, Drug, and Cosmetic Act, The Public Health Service Act, Or The Virus-Serum-Toxin Act, Or A Statement Of When The Active Ingredient Was Approved For Commercial Marketing Or Use (Either Alone Or In Combination With Other Active Ingredients), The Use For Which It Was Approved, And The Provision Of Law Under Which It Was Approved

The active ingredient in VIMPAT® injection is lacosamide, which has not been previously approved for commercial marketing or use under the Federal Food, Drug, and Cosmetic Act, the Public Health Service Act, or the Virus-Serum-Toxin Act.

5. A Statement That The Application Is Being Submitted Within The Sixty Day Period Permitted For Submission Pursuant to 37 CFR §1.720(f) And An Identification Of The Date Of The Last Day On Which The Application Could Be Submitted

This application is being submitted within the permitted sixty (60) day period, the last day of which is December 26, 2008.

6. A Complete Identification Of The Patent For Which An Extension Is Being Sought By The Name Of The Inventor, The Patent Number, The Date Of Issue, And The Date Of Expiration

The complete identification of the patent for which extension is sought is:

Inventors:	Harold Kohn, and Darrell Watson
Patent Number:	5,654,301
Issue Date:	August 5, 1997
Expiration Date:	August 5, 2014 (without extension under 35 U.S.C. §156)

7. A Copy Of The Patent For Which An Extension Is Being Sought, Including The Entire Specification (Including Claims) And Drawings

A complete copy of U.S. Patent No. 5,654,301 is annexed as **Exhibit D**.

8. A Copy Of Any Disclaimer, Certificate of Correction, Receipt Of Maintenance Fee Payment, Or Reexamination Certificate Issued In The Patent

The patent for which extension is being sought has not been the subject of any disclaimer or reexamination certificate, but has had a certificate of correction duly issued by the

U.S. Patent and Trademark Office. A copy of the certificate of correction, dated November 27, 2001, is included at the end of the copy of U.S. Patent No. 6,654,301 annexed as **Exhibit D**. The first two scheduled maintenance fees for U.S. Patent 5,654,301 were duly paid on February 2, 2001 and December 3, 2004 by Applicant, and the next maintenance fee is due to be paid by February 6, 2009. Copies of the maintenance fee statements evidencing past payments are annexed as **Exhibit E**.

9. A Statement That The Patent Claims The Approved Product Or A Method Of Using Or Manufacturing The Approved Product, And A Showing Which Lists Each Applicable Patent Claim And Demonstrates The Manner In Which At Least One Such Patent Claim Reads On The Approved Product Or Method Of Using Or Manufacturing The Approved Product

U.S. Patent No. 5,654,301 claims the approved product, VIMPAT® injection. More specifically, claims 39-45 read on the approved product and claim the active ingredient of the final approved product lacosamide, claim 46 reads on the approved product and claims a composition comprising lacosamide, and claim 47 reads on methods that comprise using lacosamide for treatment of CNS (i.e., central nervous system) disorders. Claim 39, covering a compound, is compared to the approved product in the table below.

Patent Claim	Approved Product
39. A compound of the formula $\begin{array}{c} \text{R}_2 \\   \\ \text{R}-\text{NH}(\text{C}=\text{C}\text{N}\text{H})_2\text{C}=\text{R}_1 \\    \quad   \quad    \\ \text{Q} \quad \text{R}_3 \quad \text{A} \end{array}$ or the pharmaceutically acceptable salts thereof wherein R is aryl, aryl lower alkyl, heterocyclic, heterocyclic lower alkyl, cycloalkyl or lower cycloalkyl lower alkyl, wherein R is unsubstituted or is substituted with at least one electron	The active ingredient of the approved product is lacosamide, which is (R)-2-acetamido-N-benzyl-3-methoxypropionamide. Lacosamide has the structural formula identified above in Section 1 of this application. Comparison of the structural formula above with that in claim 39 shows that the benzyl group at the far right of the structural formula identified above in Section 1 is an unsubstituted aryl lower alkyl and thus satisfies the claim's definition of "R." The -CH <sub>3</sub> group at the far left of the structure in Section 1 is a lower alkyl that satisfies the claim's definition of "R <sub>1</sub> ." The two double-bonded oxygen atoms satisfy

<p>withdrawing group or an electron donating group;</p> <p><math>R_1</math> is hydrogen or lower alkyl and <math>R_1</math> is unsubstituted or substituted with at least one electron withdrawing group or at least one electron donating group;</p> <p><math>A</math> and <math>Q</math> are both O;</p> <p>one of <math>R_2</math> and <math>R_3</math> is hydrogen and the other is lower alkyl which is substituted with an electron donating group or a electron withdrawing group and <math>n</math> is 1-4.</p>	<p>the claim's definition of both "A" and "Q." The central chiral carbon atom is bonded to a hydrogen and a -<math>CH_2OCH_3</math> group (a lower alkyl substituted with a methoxy group), thus satisfying the claim's requirement that one of <math>R_2</math> and <math>R_3</math> be a hydrogen while the other of <math>R_2</math> and <math>R_3</math> is a lower alkyl substituted with an electron donating group. A lower alkoxy, such as a -<math>OCH_3</math> group, is defined by dependent claim 43 and the specification as a suitable electron donating group. Lacosamide qualifies as a chemical defined by claim 39 when <math>n</math> is equal to 1.</p>
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Claim 46, covering a therapeutic composition, is compared to the approved product in the table below.

Patent Claim	Approved Product
46. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from any one of claim 37-42 and a pharmaceutical carrier therefor.	The active ingredient of the approved product is lacosamide, and lacosamide falls within the scope of claim 39 as indicated above. The approved product is a composition for intravenous injection that contains a pharmaceutical carrier, water and sodium chloride.

Claim 47, covering a method of treating central nervous system disorders, is compared to the approved product and its indicated use in the table below.

Patent Claim	Approved Product
47. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of any one of claims 39-	The active ingredient of the approved product is lacosamide, and lacosamide falls within the scope of claim 39 as indicated above. Lacosamide is an anticonvulsant approved for the treatment of partial-

44.	onset seizures in patients with epilepsy, which is a central nervous system ("CNS") disorder.
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10. A Statement, Beginning On A New Page, Of The Relevant Dates And Information Pursuant To 35 U.S.C. § 156(g) In Order To Enable The Secretary Of Agriculture, As Appropriate, To Determine The Applicable Regulatory Review Period As Follows (i): For A Patent Claiming A Human Drug Product, Antibiotic, Or Human Biological Product, The Effective Date Of The Investigational New Drug (IND) Application And The IND Number; The Date On Which A New Drug Application (NDA) Or A Product License Application (PLA) Was Initially Submitted And The NDA Or PLA Number And The Date On Which The NDA Was Approved Or The Product License Issued

Schwarz Biosciences, Inc. was notified via telephone that the IND for VIMPAT® injection (IND 68,407) became effective on November 14, 2003, and received a letter dated December 24, 2003 from the FDA confirming that IND 68,407 became effective on that earlier date. For purposes of this application for patent term extension, the Applicant is entitled to an IND date of at least as early as November 14, 2003.<sup>1</sup> The NDA (NDA 22-254) for VIMPAT® injection was initially submitted to the Food and Drug Administration on September 28, 2007 and was approved on October 28, 2008.

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<sup>1</sup> A predecessor in interest to Schwarz, Harris FRC Corp., previously filed IND 57,939 for VIMPAT® (lacosamide) tablet. IND 57,939 became effective on May 19, 1999, and was followed by NDA 22-253 on September 28, 2007. NDA 22-253 was approved on October 28, 2008 for VIMPAT® (lacosamide) tablet. Both NDA approvals (for NDA 22-253 and NDA 22-254) rely upon the same Phase I safety & tolerance studies for lacosamide. (See Exhibit F, page 1 for "IND 68,407 Submissions" chart indicating on October 15, 2003 a cross-referencing was made to "all preclinical and clinical reports from oral IND"). Applicant understands that, where multiple INDs are in effect, and data from such multiple INDs was material to the determination to approve the product, it is the policy of the FDA to consider whether it would be appropriate to define the testing phase as having begun when the first IND became effective. Applicant therefore submits that an earlier IND effective date, namely May 19, 1999, may be appropriate for use in calculating the full term of the regulatory review period for this patent term extension application. Applicant will supplement this application with additional information concerning IND 57,939 and/or NDA 22-253 upon request by the Patent Office and/or the FDA.

11. A Brief Description Beginning On A New Page Of The Significant Activities Undertaken By The Marketing Applicant During The Applicable Regulatory Review Period With Respect To The Approved Product And The Significant Dates Applicable To Such Activities

A brief description of significant activities undertaken by the marketing applicant during the regulatory review period with respect to the approved product is annexed as **Exhibit F**. This exhibit provides a chronology of the major communications between the marketing applicant and the Food and Drug Administration, including a brief summary of the subject matter and date of these communications.

Applicant reserves the right to supplement the chronology of **Exhibit F** with materials from which it was derived or other evidence related to Applicant's conduct in obtaining the approval of VIMPAT® injection. *See, e.g.,* 21 CFR § 60.32.

12. A Statement Beginning On A New Page That In The Opinion Of The Applicant The Patent Is Eligible For The Extension And A Statement As To The Length Of The Extension Claimed, Including How The Length Of Extension Was Determined

Applicant is of the opinion that U.S. Patent No. 5,654,301 is eligible for extension under 35 U.S.C. § 156, because it satisfies all of the requirements for such extension as follows:

a. 35 U.S.C. §156(a); 37 CFR §1.720(a)

U.S. Patent No. 5,654,301 claims a product, and a method of using a product.

b. 35 U.S.C. §156(a)(1); 37 CFR §1.720(g)

The term of U.S. Patent No. 5,654,301 has not expired before submission of this application.

c. 35 U.S.C. §156(a)(2); 37 CFR §1.720(b)

The term of U.S. Patent No. 5,654,301 has never previously been extended under 35 U.S.C. §156.

d. 35 U.S.C. §156(a)(3); 37 CFR §1.730

This application for extension is submitted by the authorized agent or the owner of record in accordance with the requirement of 35 U.S.C. §156(d) and the rules of the U.S. Patent and Trademark Office.

e. 35 U.S.C. §156(a)(4); 37 CFR §1.720(d)

The product VIMPAT® injection has been subject to a regulatory review period as defined in 35 U.S.C. §156(g) before its commercial marketing or use.

f. 35 U.S.C. §156(a)(5)(A); 37 CFR §1.720(e)(i)

The commercial marketing or use of the product VIMPAT® injection after the regulatory review period is the first permitted commercial marketing or use of the product under the provision of the Federal Food, Drug, and Cosmetics Act (21 U.S.C. §360) under which such regulatory review period occurred.

g. 35 U.S.C. §156(c)(4); 37 CFR §1.720(h)

No other patent has been extended for the same regulatory review period for the product VIMPAT® injection.

h. 35 U.S.C. §156(d)(1); 37 CFR §1.720(f)

This application is submitted within the permitted 60 day period beginning on the date the product first received permission for commercial marketing or use.

Applicant is of the opinion that U.S. Patent No. 5,654,301 is eligible for extension under 35 U.S.C. § 156 for 1104 days, as determined pursuant to 37 CFR §1.775 as follows:

Patent Information:

Patent 5,654,301 Issue Date	August 5, 1997
Earliest non-provisional priority date	February 15, 1985
Days Extension under 35 U.S.C. 154(b)	0

FDA Information:

Date IND Became Effective	November 14, 2003
Date NDA Submitted to the FDA	September 28, 2007
Date NDA Approved by the FDA	October 28, 2008

IND Period:

Start Date of Regulatory Review Period	November 14, 2003
IND Period (days)	1414
½ IND Period (days)	707

Regulatory Review Period Allowed:

NDA Review Period (days)	397
Regulatory Review Period (days)	1811
Reg. Rev. Period less ½ IND period (days)	1104

Statutory Limitations:

Patent Expiration Date (17 year term)	August 5, 2014
Expiration under 5 year extension limitation (Date 1)	August 5, 2019
Expiration under 14 from NDA approval limitation (Date 2)	October 28, 2022
Expiration based upon full review period (Date 3)	August 13, 2017
Final Expiration Date (Earliest of Date 1, Date 2, or Date 3)	August 13, 2017
<u>Maximum Extension in Days:</u>	<b>1104<sup>2</sup></b>

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<sup>2</sup> All calculations above are performed assuming that November 14, 2003 is the appropriate date for when the relevant regulatory review period started. As noted above in footnote 1 on page 8, it is possible that the FDA could determine that a date as early as May 19, 1999 is the appropriate date for the start of the regulatory review period. Should that earlier date, or another earlier date, in fact be the appropriate start date for the regulatory review period, then Applicant would be entitled to a longer calculated review period, and thus a later "Date 3" above. For example, should the applicable regulatory review period be determined to have started on May 19, 1999, then the IND period will have lasted 3054 days, and the full regulatory review period will have lasted 3451 days. Thus, the regulatory review period less ½ IND period as calculated would be 1924 days. This would make the expiration of patent no. 5,654,301 based upon the full regulatory review period (Date 3) be November 11, 2019. In this scenario, Applicant would be entitled to a full five-year extension of patent no. 5,654,301, making it expire August 5, 2019 (i.e., Date 1 above).

13. A Statement That Applicant Acknowledges A Duty To Disclose To The Commissioner Of Patents And Trademarks And The Secretary Of Health And Human Services Any Information Which Is Material To The Determination Of Entitlement To The Extension Sought

Applicant acknowledges a duty to disclose to the Commissioner of Patents and Trademarks and the Secretary of Health and Human Services any information which is material to any determinations of entitlement to the extension sought in the Application.

14. The Prescribed Fee For Receiving And Acting Upon The Application For Extension

The prescribed fee pursuant to 37 CFR §1.20(j) for receiving and acting upon this application is to be charged to the Deposit Account of Applicant's undersigned attorney as authorized in the attached letter.

15. The Name, Address, And Telephone Number Of The Person To Whom Inquiries And Correspondence Relating To The Application For Patent Term Extension Are To Be Directed

Please address all correspondence to:

Kevin G. Shaw

Hogan & Hartson, LLP

555 Thirteenth St., NW

Washington, DC 20004

16. A Duplicate Of The Application Papers, Certified As Such

Applicant hereby certifies that this application for extension is being filed in triplicate.

17. An Oath Or Declaration

Applicant, through its undersigned patent attorney authorized to practice before the Patent and Trademark Office and who has general authority from the agent or owner to act on behalf of the agent or owner in patent matters, being duly warned that willful false statements are punishable by fine or imprisonment or both under section 1001 of Title 18, United States

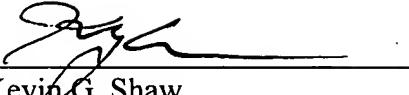
Code and that willful false statements and the like may jeopardize the validity of this application and the patent to which it relates, states and declares that the following statements made based on his own knowledge are true and that all statements made on information and belief are believed to be true:

- (1) The undersigned is registered to practice before the Patent and Trademark Office and is making this declaration as a patent attorney who has general authority to act on behalf of the applicant in patent matters.
- (2) The undersigned has reviewed and understands the contents of the application being submitted pursuant to this section;
- (3) The undersigned believes the patent is subject to an extension pursuant to 37 C.F.R. § 1.710 in the event of NDA approval and, in the interim, is subject to an extension pursuant to 37 C.F.R. § 1.790;
- (4) The undersigned believes an extension of the length claimed is justified under 35 U.S.C. 156 and the applicable regulations; and
- (5) The undersigned believes the patent for which extension is being sought meets the conditions for extension of the term of a patent as set forth in 37 C.F.R. § 1.720 in the event of NDA approval, and meets the requirements for an interim extension of a patent set forth in 37 C.F.R. § 1.790.

If this application for extension of patent term is held to be informal, applicant may seek to have that holding reviewed by filing a petition with the required fee, as necessary, pursuant to 37 C.F.R. §§ 1.181, 1.182 or 1.183, as appropriate, within such time as may be set in any notice that the application has been held to be informal, or if no time is set, within one month of the date on which the application was held informal.

Respectfully submitted,

Dated: December 23, 2008

By:   
Kevin G. Shaw  
Registration No. 43,110

**HOGAN & HARTSON LLP**  
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# Exhibit A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: U.S. Patent No. 5,654,301  
Inventor: KOHN, Harold et al.  
Issue Date: August 5, 1997  
For: AMINO ACID DERIVATIVE ANTICONVULSANT  
Assignee: Research Corporation Technologies, Inc.  
  
Attorney Docket: 32555-0002-2

POWER OF ATTORNEY FOR PATENT TERM EXTENSION APPLICATION

Research Corporation Technologies, Inc., a non-profit corporation organized and existing under the laws of Delaware, and having a principal place of business at 5210 E. Williams Circle, Suite 240, Tucson, Arizona 85711-4410, represents that it is the owner of the entire interest in and to U.S. Patent No. 5,654,301, granted to Harold Kohn and Darrell Watson for "Amino Acid Derivative Anticonvulsant," as reflected in the assignment document recorded by the U.S. Patent and Trademark Office on January 12, 1993 at Reel 006433, Frame 0347.

Research Corporation Technologies, Inc. hereby revokes all previous powers of attorney and appoints Kevin G. Shaw and the registered practitioners of Hogan & Hartson, L.L.P. included in the Customer Number provided below to prosecute this patent term extension application and to transact all business in the Patent and Trademark Office connected therewith, and further directs that all correspondence be addressed to Kevin G. Shaw at that Customer Number. The undersigned, acting in the official capacity stated below, has authority to does hereby execute this document on behalf of Research Corporation Technologies, Inc.

**Customer Number: 24633**

Please direct all inquiries to:

Kevin G. Shaw  
Telephone: (202) 637-6466  
Facsimile: (202) 637-5910



Shaun A. Kirkpatrick

President & CEO  
Research Corporation Technologies, Inc.  
5210 E. Williams Circle, Suite 240  
Tucson, AZ  
85711-4410



December 17, 2008

Date

# **Exhibit B**

**LETTER OF RELIANCE**

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Room MDW 7D55  
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Alexandria, VA 22314**

**Attn: Mary C. Till, Examiner  
Office of Patent Legal Administration**

**Schwarz Biosciences, Inc. (having its registered office at 1209, Orange Street, Wilmington, Delaware 19801, USA; "SBI") is directly held by UCB Inc. (having its registered office at 1209, Orange Street, Wilmington, Delaware 19801, USA), the latter being a directly and indirectly wholly-owned subsidiary of UCB Holdings, Inc. (having its registered office at 1209, Orange Street, Wilmington, Delaware 19801, USA) which is directly wholly-owned subsidiary of UCB S.A. (having its registered office at Allée de la Recherche 60, 1070 Brussels, Belgium).**

**Schwarz Pharma AG (having its registered office at Alfred-Nobel Strasse 10, 40789 Monheim, Germany; "SPAG") is directly held by UCB SP GmbH (having an office at Alfred-Nobel Strasse 10, 40789 Monheim, Germany) which is a directly wholly-owned subsidiary of UCB GmbH (having its registered office at Alfred-Nobel Strasse 10, 40789 Monheim, Germany), the latter being directly and indirectly held by UCB S.A. (having its registered office at Allée de la Recherche 60, 1070 Brussels, Belgium).**

**SPAG has exclusive license rights regarding lacosamide, R-2-Acetamido-N-benzyl-3-methoxypropionamide, under U.S. Patent Nos. Re38,551 and 5,654,301, as sublicensee of Harris FRC Corporation (having an office at 2137 Route 35 Holmdel, New Jersey 07733; "Harris FRC") that is licensee from Research Corporation Technologies, Inc. (having an office at 5210 E. Williams Circle, Suite 240, Tucson, Arizona 85711-4410; "RCT"). Hence, SPAG, Harris FRC, and RCT are sublicensee, licensee and assignee, respectively, of U.S. Patent Nos. Re38,551 and 5,654,301.**

**SBI, as NDA holder, authorizes RCT to rely on activities of SBI and its predecessors in interest relating to FDA approval of VIMPAT® lacosamide products as adjunctive therapy in treatment of partial-onset seizures in patients with epilepsy, in Tablet form under NDA 22-253 and in Injection form under NDA 22-254, in support of RCT's intension to apply for extension of patent term of U.S. Patent Nos. Re38,551 and 5,654,301, as provided under 35 U.S.C. §156(d) (1), 37 C.F.R. §1.730 and MPEP 2752.**

**SCHWARZ**  
**PHARMA**

Authorized by Schwarz Biosciences, Inc.

By:  \_\_\_\_\_  
for **Deborah Hogerman**  
**Senior Director, U.S. Regulatory Affairs**  
**On behalf of Schwarz Biosciences, Inc.**

Date: 12-01-08

cc: Research Corporation Technologies, Inc.  
cc: Harris FRC Corporation

# **Exhibit C**



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration  
Rockville, MD 20857

**NDA APPROVAL**

NDA 22-253

NDA 22-254

Schwarz Biosciences, Inc.  
Attention: Alan Blumberg  
Senior Director, US Regulatory Affairs  
P.O. Box 110167  
Research Triangle Park, NC 27709

Dear Mr. Blumberg:

Please refer to your new drug applications (NDAs) dated September 28, 2007, received September 28, 2007, submitted under section 505(b) of the Federal Food, Drug, and Cosmetic Act (FDCA), for Vimpat (lacosamide) Tablets, 50 mg, 100 mg, 150 mg, and 200 mg, and Vimpat (lacosamide) Injection, 200 mg per 20 ml.

We acknowledge receipt of your additional submissions dated:

November 26, 2007	March 20, 2008	April 30, 2008	July 17, 2008	September 4, 2008
December 13, 2007	April 3, 2008	May 9, 2008	July 30, 2008	September 23, 2008
January 23, 2008	April 9, 2008	May 27, 2008	August 1, 2008	October 15, 2008
February 13, 2008	April 14, 2008	June 11, 2008	August 14, 2008	October 21, 2008
February 22, 2008	April 18, 2008	July 11, 2008 (2)	August 27, 2008	

These new drug applications provide for the use of Vimpat (lacosamide) as follows:

- Vimpat (lacosamide) Tablets as adjunctive therapy in the treatment of partial-onset seizures in patients with epilepsy aged 17 years and older.
- Vimpat (lacosamide) Injection as adjunctive therapy in the treatment of partial-onset seizures in patients with epilepsy aged 17 years and older when oral administration is temporarily not feasible.

We have completed our review of these applications, as amended. They are approved, effective on the date of this letter, for use as recommended in the enclosed agreed-upon labeling text.

Your applications for Vimpat (lacosamide) Tablets and Injection (NDA 22-253, 22-254) were not referred to an FDA advisory committee because your products are members of the class of previously approved anti-epileptic drugs and the products did not pose unique concerns beyond those applicable to other members of this class.

### **REQUIRED PEDIATRIC ASSESSMENTS**

Under the Pediatric Research Equity Act (PREA) (21 U.S.C. 355c), all applications for new active ingredients, new indications, new dosage forms, new dosing regimens, or new routes of administration are required to contain an assessment of the safety and effectiveness of the product for the claimed indication(s) in pediatric patients unless this requirement is waived, deferred, or inapplicable.

We are waiving the pediatric study requirement for ages 0 to 1 month for these applications because necessary studies are impossible or highly impracticable because there are too few children with partial onset seizures in this age group to study.

In addition, we are deferring submission of your pediatric studies in partial onset seizures for ages 1 month up to 17 years for this application because this product is ready for approval for use in adults and the pediatric studies have not been completed.

Your deferred pediatric studies required by section 505B(a) of the FDCA are required postmarketing studies. The status of these postmarketing studies must be reported annually according to 21 CFR 314.81 and section 505B(a)(3)(B) of the FDCA. These required studies are listed below.

1. Deferred pediatric studies under PREA for the adjunctive treatment of partial onset seizures in pediatric patients ages 1 month up to 17 years.

Final Report Submission: July 2013

Submit final study reports to these NDAs. For administrative purposes, all submissions related to these required pediatric postmarketing studies must be clearly designated **“Required Pediatric Assessment.”**

### **RISK EVALUATION AND MITIGATION STRATEGY (REMS) REQUIREMENTS**

Title IX, Subtitle A, Section 901 of Food and Drug Administration Amendments Act of 2007 (FDAAA) amends the FDCA to authorize FDA to require the submission of a Risk Evaluation and Mitigation Strategy (REMS) if FDA determines that such a strategy is necessary to ensure that the benefits of the drug outweigh the risks (section 505-1(a)). This provision took effect on March 25, 2008.

In accordance with section 505-1 of the FDCA, as one element of a REMS, FDA may require the development of a Medication Guide as provided for under 21 CFR Part 208. Pursuant to 21 CFR Part 208, FDA has determined that Vimpat (lacosamide) poses a serious and significant public health concern requiring the distribution of a Medication Guide. The Medication Guide is

necessary for patients' safe and effective use of Vimpat (lacosamide). FDA has determined that Vimpat (lacosamide) has serious risks of which patients should be made aware because information concerning the risks could affect patients' decisions to use Vimpat (lacosamide). In addition, patient labeling could help prevent serious adverse effects related to the use of these products. Vimpat (lacosamide) may increase the risk of suicidal thoughts or behavior in patients taking anti-epileptic drugs for any indication. Under 21 CFR 208, you are responsible for ensuring that the Medication Guide is available for distribution to patients who are dispensed Vimpat (lacosamide).

Your proposed REMS, submitted on October 17, 2008, in an electronic communication, is approved. The REMS consists of the Medication Guide included with this letter and the timetable for submission of assessments of the REMS included in your October 17, 2008 submission.

Prominently identify submissions containing REMS assessments or proposed modifications of the REMS with the following wording in bold capital letters at the top of the first page of the submission:

- **NDA 22-253 & 22-254 REMS ASSESSMENT**
- **NEW SUPPLEMENT FOR NDA 22-253 & 22-254  
PROPOSED REMS MODIFICATION**  
**< other supplement identification > [if included]**  
**<REMS ASSESSMENT> [if included]**

#### **POSTMARKETING REQUIREMENTS UNDER 505(o)**

Title IX, Subtitle A, Section 901 of FDAAA amends the FDCA to authorize FDA to require holders of approved drug and biological product applications to conduct postmarketing studies and clinical trials for certain purposes, if FDA makes certain findings required by the statute (section 505(o)(3)(A), 21 U.S.C. 355(o)(3)(A)).

We have determined that an analysis of spontaneous postmarketing adverse events reported under subsection 505(k)(1) of the FDCA will not be sufficient to assess the known serious risk of developmental neurotoxicity.

Furthermore, the new pharmacovigilance system that FDA is required to establish under section 505(k)(3) has not yet been established and is not sufficient to assess this serious risk.

Therefore, based on appropriate scientific data, FDA has determined that you are required, pursuant to section 505(o)(3) of the FDCA, to conduct the following study:

2. A nonclinical study in rats to examine the effects of Vimpat (lacosamide) on brain development during the prenatal and early postnatal periods using more sensitive techniques for assessing central nervous system structure and function than were employed in the standard pre- and postnatal development study. You should consider the use of multiple daily dosing as a means of achieving higher plasma drug exposures during pregnancy and to better mimic the human exposure pattern.

The timetable you have submitted on October 28, 2008 states that you will conduct this study according to the following schedule:

Protocol Submission: Within 6 months of approval  
Final Report Submission: Within 30 months of approval

Submit protocols to your IND 57,939 with a cross-reference letter to these new drug applications (NDA) 22-253 and 22-254. Submit final reports to your NDAs 22-253 and 22-254. Please use the following designators to label prominently all submissions, including supplements, relating to this postmarketing study as appropriate:

- **Required Postmarketing Protocol under 505(o)**
- **Required Postmarketing Final Report under 505(o)**
- **Required Postmarketing Correspondence under 505(o)**

Section 505(o)(3)(E)(ii) of the FDCA requires you to report periodically on the status of any study or clinical trial required under this section. This section also requires you to periodically report to FDA on the status of any study or clinical trial otherwise undertaken to investigate a safety issue. Section 506B of the FDCA, as well as 21 CFR 314.81(b)(2)(vii) requires you to report annually on the status of any postmarketing commitments or required studies or clinical trials.

FDA will consider the submission of your annual report under section 506B and 21 CFR 314.81(b)(2)(vii) to satisfy the periodic reporting requirement under section 505(o)(3)(E)(ii) provided that you include the elements listed in 505(o) and 21 CFR 314.81(b)(2)(vii). We remind you that to comply with 505(o), your annual report must also include a report on the status of any study or clinical trial otherwise undertaken to investigate a safety issue. Failure to submit an annual report for studies or clinical trials required under 505(o) on the date required will be considered a violation of FDCA section 505(o)(3)(E)(ii) and could result in enforcement action.

## **POSTMARKETING COMMITMENTS**

We acknowledge your written commitment to conduct the following postmarketing study as described in your submission dated October 28, 2008, as outlined below:

3. *In vitro* data to determine which enzymes may be involved in the metabolism of Vimpat (lacosamide) in addition to CYP2C19.

Final Report Submission: within 18 months of approval

Submit the protocol to your IND <sup>(b)(4)</sup>. Submit nonclinical and chemistry, manufacturing, and controls protocols and all study final reports to these NDAs. In addition, under 21 CFR 314.81(b)(2)(vii) and 314.81(b)(2)(viii), you should include a status summary of each commitment in your annual report to these NDAs. The status summary should include expected summary completion and final report submission dates, any changes in plans since the last annual report, and, for clinical studies, number of patients entered into each study.

NDA 22-253

NDA 22-254

Page 5

All submissions, including supplements, relating to these postmarketing study commitments should be prominently labeled:

- **Postmarketing Study Commitment Protocol**
- **Postmarketing Study Commitment Final Report**
- **Postmarketing Study Commitment Correspondence**

### **HIGHLIGHTS WAIVER**

We are waiving the requirements of 21 CFR 201.57(d)(8) regarding the length of Highlights of prescribing information. This waiver applies to all future supplements containing revised labeling unless we notify you otherwise.

### **CONTENT OF LABELING**

As soon as possible, but no later than 14 days from the date of this letter, please submit the content of labeling [21 CFR 314.50(l)] in structured product labeling (SPL) format as described at <http://www.fda.gov/oc/datacouncil/spl.html> that is identical to the enclosed labeling (text for the package insert and Medication Guide). Upon receipt, we will transmit that version to the National Library of Medicine for public dissemination. For administrative purposes, please designate this submission, “**SPL for approved NDA 22-253 and NDA 22-254.**”

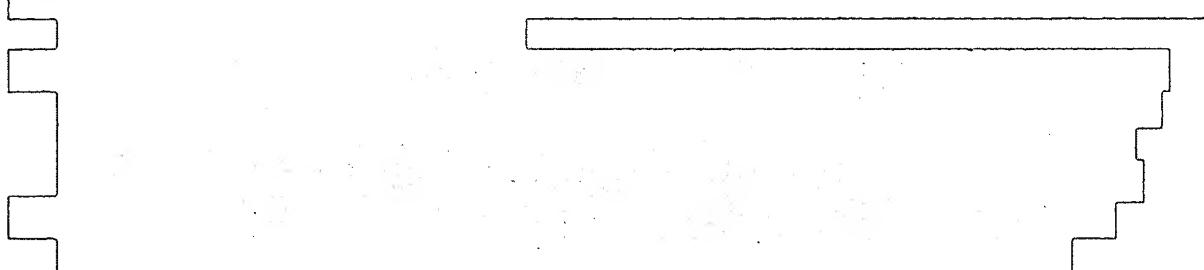
### **CARTON AND IMMEDIATE CONTAINER LABELS**

Submit final printed carton and container labels as soon as they are available, but no more than 30 days after they are printed. Please submit these labels electronically according to the guidance for industry titled *Providing Regulatory Submissions in Electronic Format – Human Pharmaceutical Product Applications and Related Submissions Using the eCTD Specifications* (October 2005). Alternatively, you may submit 12 paper copies, with 6 of the copies individually mounted on heavy-weight paper or similar material. For administrative purposes, designate this submission “**Final Printed Carton and Container Labels for approved NDA 22-253 and NDA 22-254**” Approval of this submission by FDA is not required before the labeling is used.

In addition, we note your agreement on October 28, 2008 to address and make the following changes into your carton and immediate container labels:

#### **General**

(b) (4)



1. *What is the name of the person you are writing to?*

A long, thin, horizontal rectangular frame with a thick black border. The frame is oriented horizontally and has a small, irregular black shape on the left side.

(b)(4)

(b) (4)

(b)(4)

Marketing the products with FPL that is not identical to the approved labeling text including the changes noted above may render the product misbranded and an unapproved new drug.

### **CONTROLLED SUBSTANCE CLASS**

We have recommended that this product be scheduled under the Controlled Substances Act. We remind you of the following statement that appears on the Form FDA 356h, "If this application applies to a drug product that FDA has proposed for scheduling under the Controlled Substances Act, I agree not to market the product until the Drug Enforcement Administration makes a final scheduling decision." Once a final scheduling decision is made, your label must be amended to reflect the schedule.

### **EXPIRATION DATE (Injection)**

We grant the proposed 36 month drug product expiry, when stored at controlled room temperature, for lacosamide 200 mg/20 mL injection packaged in 20 mL type I colorless glass vials with a grey rubber stopper coated with a (b)(4) and aluminum overseal.

### **PROMOTIONAL MATERIALS**

You may request advisory comments on proposed introductory advertising and promotional labeling. To do so, submit, in triplicate, a cover letter requesting advisory comments, the proposed materials in draft or mock-up form with annotated references, and the package insert(s) to:

Food and Drug Administration  
Center for Drug Evaluation and Research  
Division of Drug Marketing, Advertising, and Communications  
5901-B Ammendale Road  
Beltsville, MD 20705-1266

As required under 21 CFR 314.81(b)(3)(i), you must submit final promotional materials, and the package insert(s), at the time of initial dissemination or publication, accompanied by a Form FDA 2253. For instruction on completing the Form FDA 2253, see page 2 of the Form. For more information about submission of promotional materials to the Division of Drug Marketing, Advertising, and Communications (DDMAC), see [www.fda.gov/cder/ddmac](http://www.fda.gov/cder/ddmac).

### **LETTERS TO HEALTH CARE PROFESSIONALS**

If you issue a letter communicating important safety related information about this drug product (i.e., a "Dear Health Care Professional" letter), we request that you submit an electronic copy of the letter to both this NDA and to the following address:

MedWatch  
Food and Drug Administration  
Suite 12B05  
5600 Fishers Lane  
Rockville, MD 20857

### **REPORTING REQUIREMENTS**

We remind you that you must comply with reporting requirements for an approved NDA (21 CFR 314.80 and 314.81).

### **MEDWATCH-TO-MANUFACTURER PROGRAM**

The MedWatch-to-Manufacturer Program provides manufacturers with copies of serious adverse event reports that are received directly by the FDA. New molecular entities and important new biologics qualify for inclusion for three years after approval. Your firm is eligible to receive copies of reports for this product. To participate in the program, please see the enrollment instructions and program description details at [www.fda.gov/medwatch/report/mmp.htm](http://www.fda.gov/medwatch/report/mmp.htm).

If you have any questions, call Jacqueline H. Ware, Pharm.D., Supervisory Regulatory Project Manager, at (301) 796-1160.

Sincerely,

*{See appended electronic signature page!}*

Ellis F. Unger, M.D.  
Deputy Director (Acting)  
Office of Drug Evaluation I  
Center for Drug Evaluation and Research

Enclosures (FDA Approved Labeling Text, Medication Guide, and REMS document)

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**This is a representation of an electronic record that was signed electronically and  
this page is the manifestation of the electronic signature.**  
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/s/  
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Ellis Unger  
10/28/2008 08:00:13 PM

# **Exhibit D**

## United States Patent [19]

Kohn et al.

[11] Patent Number: 5,654,301

[45] Date of Patent: Aug. 5, 1997

[54] AMINO ACID DERIVATIVE  
ANTICONVULSANT

[75] Inventors: Harold L. Kohn, Houston; Darrell Watson, Belton, both of Tex.

[73] Assignee: Research Corporation Technologies, Inc., Tucson, Ariz.

[21] Appl. No.: 3,208

[22] Filed: Jan. 12, 1993

## Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 710,610, Jun. 4, 1991, Pat. No. 5,378,729, which is a continuation-in-part of Ser. No. 354,057, May 19, 1989, abandoned, and a continuation-in-part of Ser. No. 392,870, Aug. 11, 1989, abandoned, said Ser. No. 354,057, is a continuation-in-part of Ser. No. 80,528, Jul. 31, 1987, abandoned, which is a continuation-in-part of Ser. No. 916,254, Oct. 7, 1986, abandoned, which is a continuation-in-part of Ser. No. 702,195, Feb. 15, 1985, abandoned, said Ser. No. 392,870, is a continuation-in-part of Ser. No. 80,528, Jul. 31, 1987, abandoned, which is a continuation-in-part of Ser. No. 916,254, Oct. 7, 1986, abandoned, which is a continuation-in-part of Ser. No. 702,195, Feb. 15, 1985, abandoned.

## [30] Foreign Application Priority Data

Jun. 4, 1992 [WO] WIPO ..... US92/04687

[51] Int. Cl.<sup>6</sup> ..... A61K 31/445; A61K 31/34; C07D 211/72; C07D 261/04

[52] U.S. Cl. ..... 514/231.2; 514/315; 514/397; 514/406; 514/415; 514/424; 514/461; 514/468; 514/486; 514/616; 546/292; 548/125; 548/225; 548/250; 548/347.1; 548/245; 548/371.4; 564/152; 564/154; 564/292

[58] Field of Search ..... 564/148, 155, 564/154, 152; 548/125, 245, 371.4; 514/315, 357, 461, 406, 548, 424, 415, 549, 618, 486, 231.2; 546/252, 152, 154

## [56] References Cited

## U.S. PATENT DOCUMENTS

2,676,188	4/1954	Bruce et al.	424/319
2,721,197	10/1955	Sheehan	564/155
3,340,147	9/1967	Martin et al.	514/616
3,657,341	4/1972	Thorne et al.	260/558 A
3,707,559	12/1972	Mazur et al.	564/158
4,018,826	4/1977	Gless, Jr. et al.	564/215
4,260,684	4/1981	Schult	564/155
4,303,673	12/1981	Biedermann et al.	564/155
4,372,974	2/1983	Fish et al.	260/559
4,513,009	4/1985	Roques et al.	
4,595,700	6/1986	Donald et al.	514/616
4,618,708	10/1986	Roques et al.	564/154
4,873,241	10/1989	Napier et al.	564/215
5,378,729	1/1995	Kohn et al.	514/231.2

## FOREIGN PATENT DOCUMENTS

0885303	3/1981	Belgium	.
0007441	2/1980	European Pat. Off.	.
0194464	2/1980	European Pat. Off.	.
0038758	10/1981	European Pat. Off.	.
0042626	12/1981	European Pat. Off.	.
0046707	3/1982	European Pat. Off.	.

0263506 10/1987 European Pat. Off. .  
0400400 5/1990 European Pat. Off. .  
1927692 12/1969 Germany .  
0393355 10/1965 Switzerland .  
1051220 12/1966 United Kingdom .

## OTHER PUBLICATIONS

Remington, Pharmaceutical Sciences, Mack Publishing Company, (1980) pp. 400-427.

Chemical Abstracts, vol. 92; No. 7:51712r (Feb. 18, 1990).

Chemical Abstracts, vol. 96; No. 5:35710r (Feb. 1, 1982).

Chemical Abstracts, vol. 101; No. 9; 72124v (Aug. 27, 1984).

Chemical Abstracts, vol. 91; No. 21:175147; (Nov. 19, 1979).

Kohn, et al. (1988) Brain Research 457: 371-375, Marked Stereospecificity in a New Class of Anticonvulsants.

Chemical Abstracts, vol. 97; 145266d (1982).

Chemical Abstracts, vol. 89; 129286q; Zafroukai, et al. (1978).

White, et al. (1981) JACS, 103:4231-4239, Active-Site-Directed Inhibition of alpha-Chymotrypsin by Deaminatively Produced Carbonium Ions: An Example of Suicide of Enzyme-Activated-Substrate Inhibition.

Legall, et al. (1988) Int. J. Protein Res., 32:279-291 Synthesis of Functionalized Non-Natural Amino Acid Derivatives via Amidoalkylation Transformations.

Cortes, et al. (1985) J. Med. Chem., 28:601-606, Effect of Structural Modification of the Hydantoin Ring on Anticonvulsant Activity.

Ikeda, et al. (1977) Tetrahedron, 33(5):489-495, photochemical Synthesis of 1,2,3,4-Tetrahydroisoquinolin-3-ones from N-Chloracetylbenzylamines.

Conley, et al. (1987) J. Med. Chem., 30(3): 567-574 Functionalized DL-Amino Acid Derivatives. Potent New Agents for the Treatment of Epilepsy.

Garcia, et al. (1984) Tetrahedron Letters, 25(42) 4841-4844, New Synthetic "Tricks" Triphenylphosphine-Mediated Amide Formation from Carboxylic Acids and Azides.

Rebek, et al. (1979), J. Am. Chem. Soc., 101(3):737, On the Rate of Site-Site Interactions in Functionalized Polystyrenes.

Katritzky, et al. (1990) J. Org. Chem., 55:2206-2214, Benzotriazole-Assisted Synthesis of Monacyl Aninals and Their Peptide Derivatives.

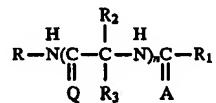
Lipshutz, et al. (1983) J. Am. Chem. Soc., 105:7703-7713, Heterocycles as masked Diamide/Dipeptide Equivalents. Formation and Reactions of Substituted 5-(Acylamino)oxazoles as Intermediates en route to the Cyclopeptide Alkaloids.

(List continued on next page.)

Primary Examiner—Theodore J. Criares  
Attorney, Agent, or Firm—Scully, Scott, Murphy & Presser

## [57] ABSTRACT

The present invention relates to compounds of the formula



## OTHER PUBLICATIONS

Lipshutz, et al. (1993) *J. Org. Chem.*, 48:3745-3750, An Approach to the Cyclo-peptide Alkaloids (Phencyclopediaes) via Heterocyclic Diamide/Dipeptide Equivalents. Preparation and N-Alkylation Studies of 2,4(5)-Disubstituted Imidazoles.

Roques, 91987) 193rd ACS National Meeting, Amer. Chem. Soc., Apr. 5-10, 1987 Use of Various Metallopeptides

Inhibitors to Study the Physiological Role of Endogenous Neuropetides.

Kohn, et al. (1990) *J. Med. Chem.*, 33:919-926, Preparation and Anticonvulsant Activity of a Series of Functionalized  $\alpha$ -Aromatic and  $\alpha$ -Heteroaromatic Amino Acids.

Lipshutz, et al. *JACS*, 106(2):457-459, "Heterocycles in Synthesis . . . Imidazoles" (1984).

Kohn, et al. (1988) *Chemistry in Britain*, pp. 231-233, New Antiepileptic Agents.

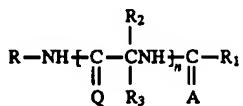
AMINO ACID DERIVATIVE  
ANTICONVULSANT  
RELATED APPLICATIONS

The present application is a continuation-in-part of U.S. patent application Ser. No. 710,610 filed on Jun. 4, 1991, now U.S. Pat. No. 5,378,729 which is a continuation-in-part of U.S. patent application Ser. No. 354,057 filed on May 19, 1989, now abandoned and U.S. patent application Ser. No. 392,870 filed on Aug. 11, 1989, now abandoned. U.S. patent application Ser. No. 354,057 is a continuation-in-part of U.S. patent application having Ser. No. 080,528, filed on Jul. 31, 1987, now abandoned, which is a continuation-in-part of U.S. patent application Ser. No. 916,254, filed Oct. 7, 1986, now abandoned which is a continuation-in-part of U.S. patent application Ser. No. 702,195, filed Feb. 15, 1985, now abandoned. U.S. patent application Ser. No. 392,870 is a continuation application of U.S. patent application having Ser. No. 080,528, filed Jul. 31, 1987, now abandoned, which is a continuation-in-part of U.S. patent application Ser. No. 916,254 filed Oct. 7, 1986, now abandoned which is a continuation-in-part of U.S. patent application Ser. No. 702,195 filed on Feb. 15, 1985, now abandoned.

This invention was made with Government support under NS15604 awarded by the National Institutes of Health. The Government has certain rights to this invention.

## BACKGROUND OF THE INVENTION

The present invention relates to compounds and pharmaceutical compositions having central nervous system (CNS) activity which are useful in the treatment of epilepsy and other CNS disorders. More specifically, the compounds of this invention can be characterized as protected amino acid derivatives of the formula:



or the N-oxides thereof or pharmaceutically acceptable salts thereof wherein

R is hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl, aryl lower alkyl, heterocyclic, heterocyclic lower alkyl, lower alkyl heterocyclic, lower cycloalkyl, lower cycloalkyl lower alkyl, and R is unsubstituted or is substituted with at least one electron withdrawing group or electron donating group;

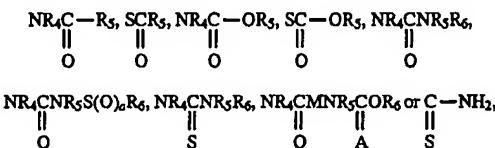
R<sub>1</sub> is hydrogen or lower alkyl, lower alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic lower alkyl, heterocyclic, lower cycloalkyl, lower cycloalkyl lower alkyl, each unsubstituted or substituted with an electron donating group or an electron withdrawing group and

R<sub>2</sub> and R<sub>3</sub> are independently hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic, heterocyclic lower alkyl, lower alkyl heterocyclic, lower cycloalkyl, lower cycloalkyl lower alkyl, SO<sub>3</sub><sup>-</sup> or Z—Y wherein R<sub>2</sub> and R<sub>3</sub> may be unsubstituted or substituted with at least one electron withdrawing group or electron donating group;

Z is O, S(O)<sub>a</sub>, NR<sub>4</sub>, PR<sub>4</sub> or a chemical bond;

Y is hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, lower alkynyl, halo, heterocyclic, heterocyclic lower alkyl, cycloalkyl, cycloalkyl lower alkyl and Y may be unsubstituted or substituted with an electron donating group or an electron withdrawing group, provided Z is a chemical bond only, when Y is halo, or

ZY taken together is NR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>, NR<sub>4</sub>OR<sub>5</sub>, ONR<sub>4</sub>R<sub>7</sub>, OPR<sub>4</sub>R<sub>5</sub>, PR<sub>4</sub>OR<sub>5</sub>, SNR<sub>4</sub>R<sub>7</sub>, NR<sub>4</sub>SR<sub>7</sub>, SPR<sub>4</sub>R<sub>5</sub>, PR<sub>4</sub>SR<sub>7</sub>, NR<sub>4</sub>PR<sub>3</sub>R<sub>6</sub>, PR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>.



R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> are independently hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, or lower alkynyl, wherein R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> may be unsubstituted or substituted with an electron withdrawing group or an electron donating group and

R<sub>7</sub> is R<sub>6</sub> or COOR<sub>8</sub> or COR<sub>8</sub>

R<sub>8</sub> is hydrogen or lower alkyl, or aryl lower alkyl, and the aryl or alkyl group may be unsubstituted or substituted with an electron withdrawing group or an electron donating group and

A and Q are independently O or S, M is an alkylene chain containing up to 6 carbon atoms or a chemical bond; n is 1-4 and a is 1-3.

The predominant application of anticonvulsant drugs is the control and prevention of seizures associated with epilepsy or related central nervous system disorders. Epilepsy refers to many types of recurrent seizures produced by paroxysmal excessive neuronal discharges in the brain; the two main generalized seizures are petit mal, which is associated with myoclonic jerks, akinetic seizures, transient loss of consciousness, but without convulsion; and grand mal which manifests in a continuous series of seizures and convulsions with loss of consciousness.

The mainstay of treatment for such disorders has been the long-term and consistent administration of anticonvulsant drugs. Most drugs in use are weak acids that, presumably, exert their action on neurons, glial cells or both of the central nervous system. The majority of these compounds are characterized by the presence of at least one amide unit and one or more benzene rings that are present as a phenyl group or part of a cyclic system.

Much attention has been focused upon the development of anticonvulsant drugs and today many such drugs are well known. For example, the hydantions, such as phenytoin, are useful in the control of generalized seizures and all forms of partial seizures. The oxazolidinediones, such as trimethadione and paramethadione, are used in the treatment of non-convulsive seizures. Phenacetamide, a phenylacetyleurea, is one of the most well known anticonvulsants employed today, while much attention has recently been dedicated to the investigation of the diazepines and piperazines. For example, U.S. Pat. Nos. 4,002,764 and 4,178,378 to Allgeier, et al. disclose esterified diazepine derivatives useful in the treatment of epilepsy and other nervous disorders. U.S. Pat. No. 3,887,543 to Nakanishi, et al. describes a thieno[2,3-e][1,4]diazepine compound also having anticonvulsant activity and other depressant activity. U.S. Pat. No. 4,209,516 to Heckendorf, et al. relates to triazole derivatives which exhibit anticonvulsant activity and are useful in the treatment of epilepsy and conditions of tension and agitation. U.S. Pat. No. 4,322,974 to Fish, et al. discloses a pharmaceutical formulation containing an aliphatic amino acid compound in which the carboxylic acid and primary amine are separated by three or four units. Administration of these compounds in an acid pH range are useful in the

treatment of convulsion disorders and also possess anxiolytic and sedative properties.

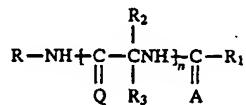
Unfortunately, despite the many available pharmacotherapeutic agents, a significant percentage of the population with epilepsy or related disorders are poorly managed. Moreover, none of the drugs presently available are capable of achieving total seizure control and most have disturbing side-effects. Clearly, current therapy has failed to "seize control" of these debilitating diseases.

It is therefore one object of the present invention to provide novel compounds exhibiting CNS activity, particularly anticonvulsant activity.

Another object of this invention is to provide pharmaceutical compositions useful in the treatment of epilepsy and other CNS disorders.

A further object of this invention is to provide a method of treating epilepsy and related convulsant disorders.

These and other objects are accomplished herein by providing compounds of the following general formula:



wherein R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, n, Z, Y, A and Q are as defined hereinabove.

The present invention contemplates employing the compounds of Formula I in compositions of pharmaceutically acceptable dosage forms. Where the appropriate substituents are employed, the present invention also includes pharmaceutically acceptable addition salts. Moreover, the administration of an effective amount of the present compounds, in their pharmaceutically acceptable forms or the addition salts thereof, can provide an excellent regime for the treatment of epilepsy, nervous anxiety, psychosis, insomnia and other related central nervous disorders.

The alkyl groups when used alone or in combination with other groups, are lower alkyl containing from 1 to 6 carbon atoms and may be straight chain or branched. These groups include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tertiary butyl, amyl, hexyl, and the like.

The aryl lower alkyl groups include, for example, benzyl, phenethyl, phenpropyl, phenisopropyl, phenbutyl, and the like, diphenylmethyl, 1,1-diphenylethyl, 1,2-diphenylethyl, and the like.

The term aryl, when used alone or in combination, refers to an aromatic group which contains from 6 up to 18 ring carbon atoms and up to a total of 25 carbon atoms and includes the polynuclear aromatics. These aryl groups may be monocyclic, bicyclic, tricyclic or polycyclic and are fused rings. Polynuclear aromatic compound is meant to encompass bicyclic, tricyclic fused aromatic ring system containing from 10-18 ring carbon atoms and up to a total of 25 carbon atoms. The aryl group includes phenyl, and the polynuclear aromatics e.g., naphthyl, anthracenyl, phenanthrenyl, azulenyl and the like. The aryl group also includes groups like ferrocenyl.

Lower alkenyl is an alkenyl group containing from 2 to 6 carbon atoms and at least one double bond. These groups may be straight chained or branched and may be in the Z or E form. Such groups include vinyl, propenyl, 1-but enyl, isobut enyl, 2-but enyl, 1-pent enyl, (Z)-2-pent enyl, (E)-2-pent enyl, (Z)-4-methyl-2-pent enyl, (E)-4-methyl-2-pent enyl, pentadienyl, e.g., 1,3 or 2,4-pentadienyl, and the like.

The term alkynyl include alkyne substituents containing 2 to 6 carbon atoms and may be straight chained as well as

branched. It includes such groups as ethynyl, propynyl, 1-butynyl, 2-butynyl, 1-pentylnyl, 2-pentylnyl, 3-methyl-1-pentylnyl, 3-pentylnyl, 1-hexynyl, 2-hexynyl, 3-hexynyl and the like.

The term cycloalkyl when used alone or in combination is a cycloalkyl group containing from 3 to 18 ring carbon atoms and up to a total of 25 carbon atoms. The cycloalkyl groups may be monocyclic, bicyclic, tricyclic, or polycyclic and the rings are fused. The cycloalkyl may be completely saturated or partially saturated. Examples include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclodecyl, cyclohexenyl, cyclopentenyl, cyclooctenyl, cycloheptenyl, decalinyl, hydroindanyl, indanyl, fenchyl, pinenyl, adamantyl, and the like. Cycloalkyl includes the cis or trans forms. Furthermore, the substituents may either be in endo or exo positions in the bridged bicyclic systems.

The term "electron-withdrawing and electron donating" refer to the ability of a substituent to withdraw or donate electrons relative to that of hydrogen if the hydrogen atom occupied the same position in the molecule. These terms are well understood by one skilled in the art and are discussed in *Advanced Organic Chemistry*, by J. March, John Wiley and Sons, New York N.Y., pp. 16-18 (1985) and the discussion therein is incorporated herein by reference. Electron

25 withdrawing groups include halo, including bromo, fluoro, chloro, iodo and the like; nitro, carboxy, lower alkenyl, lower alkynyl, formyl, carboxyamido, aryl, quaternary ammonium, trifluoromethyl, aryl lower alkanoyl, carbalkoxy and the like. Electron donating groups include such

30 groups as hydroxy, lower alkoxy, including methoxy, ethoxy and the like; lower alkyl, such as methyl, ethyl, and the like; amino, lower alkylamino, di(loweralkyl)amino, aryloxy such as phenoxy, mercapto, lower alkylthio, lower alkylmercapto, disulfide (lower alkylthio) and the like.

35 One skilled in the art will appreciate that the aforesaid substituents may have electron donating or electron withdrawing properties under different chemical conditions. Moreover, the present invention contemplates any combination of substituents selected from the above-identified groups.

40 The term halo includes fluoro, chloro, bromo, iodo and the like.

The term acyl includes lower alkanoyl.

As employed herein, the heterocyclic substituent contains 45 at least one sulfur, nitrogen or oxygen, but also may include one or several of said atoms. The heterocyclic substituents contemplated by the present invention include heteroaromatics and saturated and partially saturated heterocyclic compounds. These heterocyclics may be monocyclic, bicyclic, tricyclic or polycyclic and are fused rings. They may contain up to 18 ring atoms and up to a total of 17 ring carbon atoms and a total of up to 25 carbon atoms. The heterocyclics are also intended to include the so-called benzoheterocycles. Representative heterocyclics include

55 furyl, thienyl, pyrazolyl, pyrrolyl, imidazolyl, indolyl, thiazolyl, oxazolyl, isothiazolyl, isoxazolyl, piperidyl, pyrrolinyl, piperazinyl, quinolyl, triazolyl, tetrazolyl, isoquinolyl, benzofuryl, benzothienyl, morpholinyl, benzoxazolyl, tetrahydrofuryl, pyranyl, indazolyl, purinyl, 60 indolinyl, pyrazolidinyl, imidazolinyl, imidazolidinyl, pyrrolidinyl, furazanyl, N-methylindolyl, methylfuryl, pyridazinyl, pyrimidinyl, pyrazinyl, pyridyl, epoxy, aziridino, oxetanyl, azetidinyl, the N-oxides of the nitrogen containing heterocycles, such as the nitric oxides of pyridyl, 65 pyrazinyl, and pyrimidinyl and the like. The preferred heterocyclic are thienyl, furyl, pyrrolyl, benzofuryl, benzothienyl, indolyl, methylpyrrolyl, morpholinyl, pyridyl,

pyrazinyl, imidazolyl, pyrimidinyl, pyrazolyl or pyridazinyl. The preferred heterocyclic is a 5 or 6-membered heterocyclic compound. The especially preferred heterocyclic is furyl, pyridyl, pyrazinyl, imidazolyl, pyrazolyl, triazolyl, tetrazolyl, oxadiazolyl, epoxy, pyrimidinyl, or pyridazinyl. The most preferred heterocyclics are furyl, pyrazolyl, pyrrolyl and pyridyl.

The preferred compounds are those wherein n is 1, but di, tri and tetrapeptides are also contemplated to be within the scope of the claims.

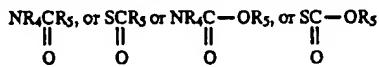
The preferred values of R is aryl lower alkyl, especially benzyl, and the preferred R<sub>1</sub> is H or lower alkyl. The most preferred R<sub>1</sub> group is methyl.

The most preferred electron donating substituent and electron withdrawing substituent are halo, nitro, alkanoyl, formyl, arylalkanoyl, aryloyl, carboxyl, carbalkoxy, carboxamide, cyano, sulfonyl, sulfoxide, heterocyclic, guanidine, quaternary ammonium, lower alkenyl, lower alkynyl, sulfonium salts, hydroxy, lower alkoxy, lower alkyl, amino, lower alkylamino, di(loweralkyl)amino, amine lower alkyl mercapto, mercaptoalkyl, alkylthio; and alkylidithio. The term "sulfide" encompasses mercapto, mercapto alkyl and alkylthio, while the term disulfide encompasses alkylidithio. These preferred substituents may be substituted on any one of R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub> or R<sub>6</sub>, R<sub>7</sub> or R<sub>8</sub> as defined herein.

The ZY groups representative of R<sub>2</sub> and R<sub>3</sub> include hydroxy, alkoxy, such as methoxy, ethoxy, aryloxy, such as phenoxy; thioalkoxy, such as thiomethoxy, thioethoxy; thioaryloxy such as thiophenoxy; amino; alkylamino, such as methylamino, ethylamino; arylamino, such as anilino; lower dialkylamino, such as, dimethylamino; trialkyl ammonium salt, hydrazino, alkylhydrazino and arylhydrazino, such as N-methylhydrazino, N-phenylhydrazino, carbalkoxy hydrazino, aralkoxycarbonyl hydrazino, aryloxycarbonyl hydrazino, hydroxylamino, such as N-hydroxylamino (—NH—OH), lower alkoxy amino [(NHOR<sub>18</sub>) wherein R<sub>18</sub> is lower alkyl], N-lower alkylhydroxyl amino [(NCR<sub>18</sub>)OH wherein R<sub>18</sub> is lower alkyl], N-lower alkyl-O-lower alkyl hydroxylamino, i.e., [N(R<sub>18</sub>)OR<sub>19</sub> wherein R<sub>18</sub> and R<sub>19</sub> are independently lower alkyl] and o-hydroxylamino (—O—NH<sub>2</sub>); alkylamido such as acetamido, trifluoroacetamido, lower alkoxyamino, (e.g. NH(OCH<sub>3</sub>); and heterocyclicamino, such as pyrazoylamino.

Furthermore, in still another embodiment Z may be O, S, NR<sub>4</sub> or PR<sub>4</sub> and Y may be hydrogen, lower alkyl or aryl and R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, n and a are as defined hereinabove.

In a still further embodiment, ZY may be



and R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, n and a are as defined hereinabove.

When R<sub>2</sub> or R<sub>3</sub> is heterocyclic, the preferred heterocyclics are furyl, tetrahydrofuryl, pyridyl, pyrazinyl, imidazolyl, pyrazolyl, triazolyl, tetrazolyl, oxadiazolyl or epoxy. The most preferred heterocyclic is furyl, pyridyl, pyrazolyl and pyrrolyl.

The preferred heterocyclic groups representative of R<sub>2</sub> and R<sub>3</sub> have the formula

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or those corresponding partially or fully saturated form thereof wherein n is 0 or 1

A, Z, L and J are independently CH, or a heteroatom selected from the group consisting of N, O, S, and G is CH, or a heteroatom selected from the group consisting of N, O and S,

but when n is 0, G is CH, or a heterocyclic selected from the group consisting of NH, O and S with the proviso that at most two of A, E, L, J and G are heteroatoms.

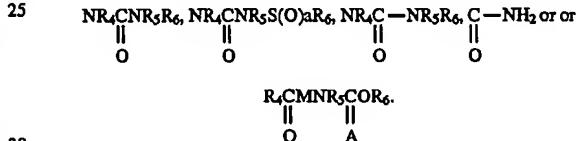
If the ring depicted hereinabove contains a nitrogen ring atom, then the N-oxide forms are also contemplated to be within the scope of the invention.

When R<sub>2</sub> or R<sub>3</sub> is a heterocyclic of the above formula, it may be bonded to the main chain by a ring carbon atom.

When n is 0, R<sub>2</sub> or R<sub>3</sub> may additionally be bonded to the main chain by a nitrogen ring atom.

R<sub>2</sub> or R<sub>3</sub> may independently also be SO<sub>3</sub><sup>-</sup>, or SO<sub>2</sub><sup>-</sup>.

Furthermore, ZY may also be



When R<sub>2</sub> is alkenyl the alkenyl group is a lower alkenyl group having 1-6 carbon atoms. The alkenyl group may be substituted with an electron donating group and more preferably with an electron withdrawing group, such as COOH.

As indicated hereinabove, Q and A may be O or S; in other words, the main chain may contain only C=O, only C=S or combinations thereof. All such permutations are contemplated herein. It is preferred that the compounds of the present invention contain no more than 2 C=S moieties, it is even more preferred that the compounds of the present invention contain no more than 1 C=S moiety. The most preferred embodiment are when A and Q are both oxygen.

An embodiment of the present application is one in which the compounds are of Formula I wherein R is lower cycloalkyl or lower cycloalkyl lower alkyl, and R is unsubstituted or is substituted with at least one electron withdrawing group or electron donating group and R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, Z, Y or ZY taken together, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, n and a are as defined herein.

Another embodiment of the present invention include compounds of Formula I wherein R<sub>1</sub> is lower cycloalkyl or lower cycloalkyl lower alkyl and R<sub>1</sub> may be unsubstituted or substituted with an electron donating group or electron withdrawing group and R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, Z, Y, or ZY taken together, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub> n and a are as defined hereinabove.

Another embodiment of the present invention includes compounds of Formula I wherein R<sub>2</sub> is lower cycloalkyl or lower cycloalkyl lower alkyl and R<sub>2</sub> may be unsubstituted or substituted with an electron donating group or electron withdrawing group, and R, R<sub>1</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub> and a are as defined hereinabove.

Still another embodiment of the present invention include compounds of Formula I wherein R<sub>3</sub> is lower cycloalkyl or lower cycloalkyl lower alkyl and R<sub>3</sub> may be unsubstituted or substituted with an electron donating or electron withdraw-

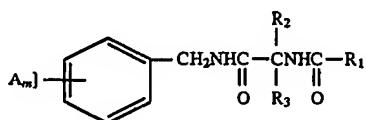
ing group and R, R<sub>1</sub>, R<sub>2</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, n and a are as defined hereinabove.

A further embodiment of the present invention include compounds of Formula I wherein Z is S(O)<sub>2</sub> and R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, Y, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, R<sub>7</sub>, R<sub>8</sub>, n and a are as defined herein. 5

It is preferred that one of R<sub>2</sub> and R<sub>3</sub> is hydrogen.

In a preferred embodiment, one of R<sub>2</sub> and R<sub>3</sub> is hydrogen and that the other is heterocyclic. It is preferred that one of R<sub>2</sub> and R<sub>3</sub> is a heterocyclic having Formula XI. The preferred heterocyclics include furyl, thienyl, benzothienyl, benzofuryl, oxazolyl, thiazolyl, isoxazolyl, indolyl, pyrazolyl, isoxazolidinyl, benzothienyl, benzofuryl, morpholinyl, indolyl, pyrrolyl, furfuryl, and methylpyrrolyl, pyridyl, pyrazinyl, imidazolyl, pyrimidinyl or pyridazinyl, pyrazolyl, or epoxy. In another preferred embodiment, one of R<sub>2</sub> and R<sub>3</sub> is alkyl (e.g. methylisopropyl), aryl (e.g., phenyl), 2-thiomethylethyl, lower alkoxy (e.g., ethoxy, methoxy), anilino, propenyl, alkylamino (e.g., ethylamino or methylamino). In another preferred embodiment, one of R<sub>2</sub> and R<sub>3</sub> is hydrogen and the other is heterocyclic lower alkyl, lower alkenyl, amino, lower alkoxy amino, N-lower 20 alkylhydroxyamino, lower alkoxyamino, N-lower alkyl-O-lower alkylhydroxyamino or aralkoxycarbonylhydrazino.

Preferred compounds of the present invention have the following general formula:

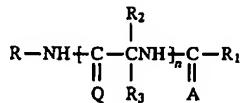


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wherein R<sub>1</sub> is H or lower alkyl, R<sub>2</sub> and R<sub>3</sub> are as defined above and A is hydrogen or an electron donating group or electron-withdrawing group and m is 0-5. It is preferred that A is hydrogen (i.e., m=0). However, values of m equalling 35 1, 2 or 3 are also preferred.

Preferred embodiments include compounds of Formula I



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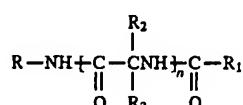
wherein

R and R<sub>1</sub>, independently, are hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic, lower alkyl heterocyclic, each unsubstituted or substituted with at least one substituent; 45

R<sub>2</sub> and R<sub>3</sub>, independently, are hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic, lower alkyl heterocyclic, each unsubstituted or substituted with at least one substituent; halogen or a heteroatom containing oxygen, nitrogen, sulfur or phosphorous substituted with hydrogen, lower alkyl or aryl, said lower alkyl or aryl groups being substituted or unsubstituted; and 55

n is 1 to 4.

Another preferred embodiment is a compound having Formula I



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wherein

R is aryl, aryl lower alkyl, heterocyclic, lower alkyl heterocyclic, polynuclear aromatic or lower alkyl poly-

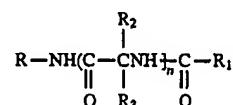
nuclear aromatic, each unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

R<sub>1</sub> is H or lower alkyl, unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

R<sub>2</sub> and R<sub>3</sub>, independently, are hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl, aryl lower alkyl, heterocyclic, lower alkyl heterocyclic, polynuclear aromatic, lower alkyl polynuclear aromatic, each unsubstituted or substituted with at least one electron donating substituent, halogen or a heteroatom containing oxygen, nitrogen, sulfur or phosphorous substituted with hydrogen, lower alkyl or aryl, said lower alkyl or aryl groups being substituted or unsubstituted; and

n is 1 to 4.

Another preferred embodiment of the present invention is a compound of Formula I



wherein

R is aryl lower alkyl, heterocyclic, lower alkyl heterocyclic, polynuclear aromatic or lower alkyl polynuclear aromatic, each of which may be unsubstituted or substituted with at least one halo, nitro, acyl, carboxyl, carboalkoxy, carboxamide, cyano, sulfonyl, sulfoxide (sulfinyl), heterocyclic, guanidine, quaternary ammonium hydroxy, alkoxy, alkyl, amino, phenoxy, mercapto, sulfide or disulfide;

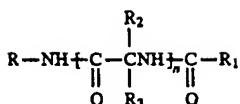
R<sub>1</sub> is H or lower alkyl which may be unsubstituted or substituted with at least one halo, nitro, acyl, carboxamide, cyano, sulfonyl, sulfoxide (sulfinyl), heterocyclic, guanidine, quaternary ammonium, hydroxy, lower alkoxy, amino, phenoxy, sulfide, or disulfide;

R<sub>2</sub> is hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl, heterocyclic, lower alkyl heterocyclic, polynuclear aromatic, lower alkyl polynuclear aromatic, each unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent; halogen or a heteroatom consisting of oxygen, nitrogen, sulfur or phosphorous, said heteroatom being substituted with hydrogen, lower alkyl or aryl, said lower alkyl or aryl groups being substituted or unsubstituted;

R<sub>3</sub> is hydrogen, lower alkyl, lower alkenyl, lower alkynyl, aryl, heterocyclic, lower alkyl heterocyclic, polynuclear aromatic, lower alkyl polynuclear aromatic, each unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent; halogen or a heteroatom consisting of oxygen, nitrogen, sulfur, or phosphorous said heteroatom being substituted with hydrogen, lower alkyl or aryl, said lower alkyl or aryl groups being substituted or unsubstituted;

and n is 1 to 4;

Another preferred embodiment is a compound of Formula I



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wherein

R is aryl, aryl lower alkyl, heterocyclic or heterocyclic lower alkyl and R is unsubstituted or is substituted with at least one electron withdrawing group, or electron 10

R<sub>1</sub> is hydrogen or lower alkyl, unsubstituted or substituted with an electron donating group or an electron withdrawing group and

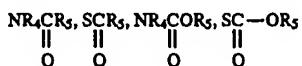
R<sub>2</sub> and R<sub>3</sub> are independently hydrogen, lower alkyl, lower 15 alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic, heterocyclic lower alkyl, or Z-Y wherein R<sub>2</sub> and R<sub>3</sub> may be unsubstituted or substituted with at least one electron withdrawing group or electron

donating group;

Z is O, S(S(O)<sub>a</sub>, NR<sub>4</sub>, PR<sub>4</sub> or a chemical bond;

Y is hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, lower alkynyl, heterocyclic, heterocyclic lower alkyl, or halo and Y may be unsubstituted or substituted with an electron donating group or an electron withdrawing group, provided that when Y is halo, Z is a chemical bond, or

ZY taken together is NR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>, NR<sub>4</sub>OR<sub>5</sub>, ONR<sub>4</sub>R<sub>7</sub>, OPR<sub>4</sub>R<sub>5</sub>, PR<sub>4</sub>OR<sub>5</sub>, SNR<sub>4</sub>R<sub>7</sub>, NR<sub>4</sub>SR<sub>7</sub>, SPR<sub>4</sub>R<sub>5</sub> or PR<sub>4</sub>SR<sub>7</sub>, NR<sub>4</sub>PR<sub>5</sub>R<sub>6</sub> or PR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>,



R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> are independently hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, or lower alkynyl, wherein R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> may be unsubstituted or substituted with an electron withdrawing group or an electron

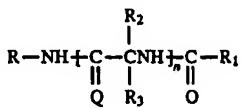
donating group and R<sub>7</sub> is R<sub>8</sub> or COOR<sub>8</sub> or COR<sub>8</sub>, R<sub>8</sub> is hydrogen or lower alkyl, or aryl lower alkyl, wherein the aryl or lower alkyl groups may be unsubstituted or substituted with an electron withdrawing or electron

donating group,

n is 1-4 and

a is 1-3.

Another class of preferred compounds of the Formula I have the formula



wherein

R is aryl, aryl lower alkyl, heterocyclic or heterocyclic alkyl which is unsubstituted or substituted with at least one electron withdrawing group or at least one electron

donating group;

R<sub>1</sub> is hydrogen or lower alkyl which is unsubstituted or substituted with at least one electron withdrawing group or one electron

donating group;

R<sub>2</sub> and R<sub>3</sub> are independently hydrogen, lower alkenyl, lower alkynyl, aryl, aryl lower alkyl, Z-Y or a heterocyclic group which may be unsubstituted or substituted with at least one electron withdrawing or one

electron donating group, with the proviso that R<sup>2</sup> and R<sup>3</sup> cannot both be hydrogen;

Z is O, S, NR<sub>4</sub>, PR<sub>4</sub> or a chemical bond;

Y is hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, lower alkynyl or halo, and Y may be unsubstituted or substituted with an electron donating group or an electron withdrawing group, provided that when Y is halo, Z is a chemical bond; or

ZY taken together is NR<sub>4</sub>NR<sub>5</sub>R<sub>6</sub>, NR<sub>4</sub>OR<sub>5</sub>, ONR<sub>4</sub>R<sub>5</sub>, OPR<sub>4</sub>R<sub>5</sub>, PR<sub>4</sub>OR<sub>5</sub>, SNR<sub>4</sub>R<sub>5</sub>, NR<sub>4</sub>SR<sub>5</sub>, SPR<sub>4</sub>R<sub>5</sub>, or PR<sub>4</sub>SR<sub>5</sub>, NR<sub>4</sub>PR<sub>5</sub>R<sub>6</sub> or PR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>.

R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> are independently hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, or lower alkynyl, wherein R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> may be unsubstituted or substituted with an electron withdrawing group or an electron

donating group;

n is 1-4.

Of this preferred group, it is especially preferred that n is 1.

20 The preferred compounds are those in which R is aryl, aryl lower alkyl, heterocyclic, or heterocyclic lower alkyl, R<sub>1</sub> is hydrogen or lower alkyl, R<sub>2</sub> and R<sub>3</sub> are independently hydrogen, heterocyclic, lower alkyl, aryl, lower alkoxy, lower alkenyl, amino, hydroxylamino, lower alkoxy amino, 25 N-lower alkyl hydroxylamino, N-lower alkyl-o-lower alkyl hydroxylamino, aralkoxy carbonyl hydrazino or alkylmercapto and n is 1.

In another preferred embodiment, n is 1, R and R<sub>1</sub> are as defined hereinabove and one of R<sub>2</sub> and R<sub>3</sub> is hydrogen and 30 the other is heterocyclic, heterocyclic lower alkyl, aryl N-hydroxylamino, lower alkoxyamino, N-lower alkylhydroxylamino, N-lower alkyl-O-lower alkylhydroxylamino.

Another preferred embodiment is wherein n is 1, R and R<sub>1</sub> 35 are as defined hereinabove, one of R<sub>2</sub> and R<sub>3</sub> is as defined hereinabove or the other is heterocyclic, heterocyclic lower alkyl, lower alkyl heterocyclic, aryl, N-hydroxylamino, lower alkoxy amino, N-lower alkyl hydroxylamino, N-lower alkyl-o-lower alkyl hydroxylamino, lower alkoxy, dialkyl

40 lower amino, lower alkylamino, aryl lower alkoxy hydrazino, or lower alkylmercapto.

The various combination and permutations of the Markush groups of R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R and n described herein are contemplated to be within the scope of the present invention.

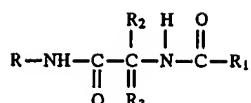
45 Moreover, the present invention also encompasses compounds and compositions which contain one or more elements of each of the Markush groupings in R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, n and R and the various combinations thereof. Thus, for example, the present invention contemplates that R<sub>1</sub> may be one or 50 more of the substituents listed hereinabove in combination with any and all of the substituents of R<sub>2</sub>, R<sub>3</sub> and R with respect to each value of n.

The compounds of the present invention may contain one (1) or more asymmetric carbons and may exist in racemic

55 and optically active forms. The configuration around each asymmetric carbon can be in either the D or L form. (It is well known in the art that the configuration around a chiral carbon atoms can also be described as R or S in the Cahn-Prelog-Ingold nomenclature system). All of the various

60 configurations around each asymmetric carbon, including the various enantiomers and diastereomers as well as racemic mixtures and mixtures of enantiomers, diastereomers or both are contemplated by the present invention.

In the principal chain, there exists asymmetry at the 65 carbon atoms to which the groups R<sub>2</sub> and R<sub>3</sub> are attached as substituted. When n is 1, the compounds of the present invention is of the formula



wherein R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub>, Z and Y are as defined previously. As used herein, the term configuration shall refer to the configuration around the carbon atom to which R<sub>2</sub> and R<sub>3</sub> are attached, even though other chiral centers may be present in the molecule. Therefore, when referring to a particular configuration, such as D or L, it is to be understood to mean the stereoisomer, including all possible enantiomers and diastereomers. The compounds of the present invention are directed to all of the optical isomers, i.e., the compounds of the present invention are either the L-stereoisomer or the D-stereoisomer. These stereoisomers may be found in mixtures of the L and D stereoisomer, e.g., racemic mixtures. The D stereoisomer is preferred.

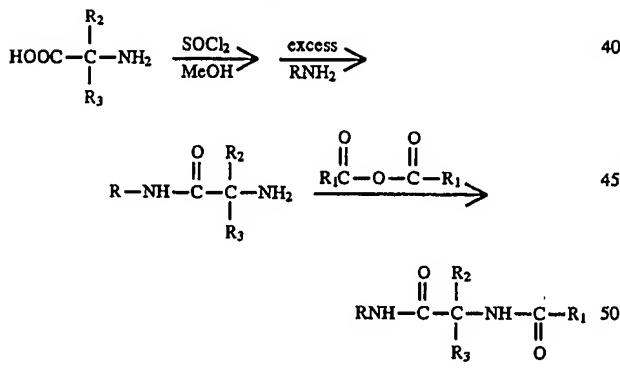
Depending upon the substituents, the present compounds may form addition salts as well. All of these forms are contemplated to be within the scope of this invention including mixtures of the stereoisomeric forms.

The following three schemes of preparation are generally exemplary of the process which can be employed for the preparation of the present complex. Although the compounds in the schemes hereinabove contain only the

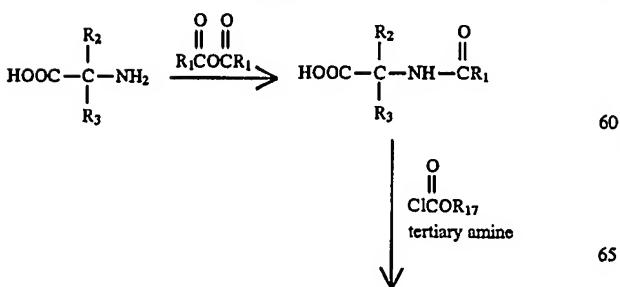


moiety, it is just as applicable to compounds of Formula I wherein either A or Q is sulfur or both A or Q are sulfur.

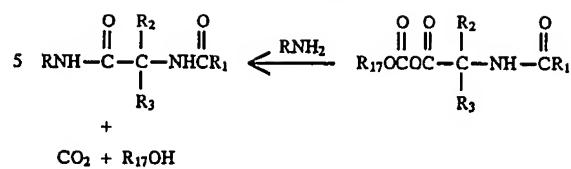
Scheme I



Scheme II



-continued  
Scheme II

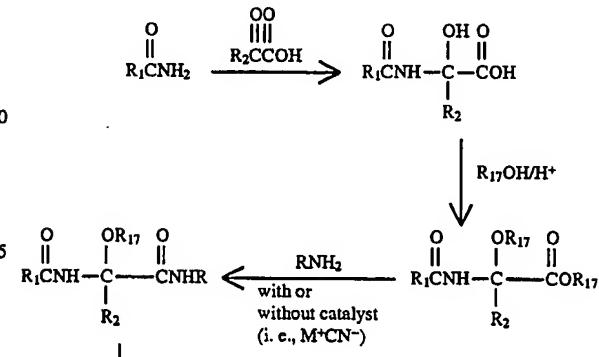


wherein

R<sub>17</sub>=lower alkyl, aryl, aryl lower alkyl,

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Scheme III



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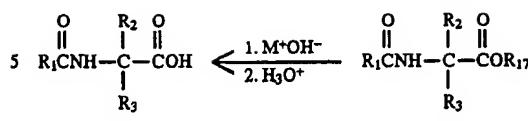
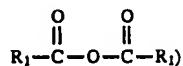
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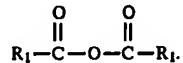
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wherein X is Cl, Br and the like), anhydrides (e.g.,

**-continued**  
**Scheme IV**



mixed anhydrides, lower alkyl esters, carbodiimides, carbonyliimidazoles, and the like. It is preferred that the acylating derivative used is the anhydride, 10

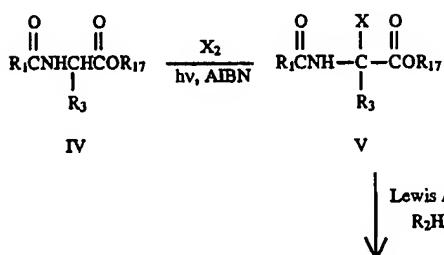


When alkyl esters are employed, amide bond formation can be catalyzed by metal cyanides such as sodium or potassium cyanides. 20

Another exemplary procedure for preparing compounds wherein at least one of  $R_2$  and  $R_3$  is aromatic or heteroaromatic is depicted in Scheme IV. 25

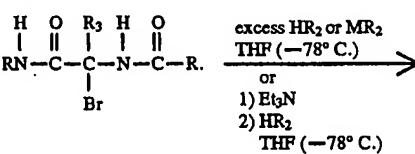
The ester (IV) is reacted with halogen and ultraviolet light in the presence of a catalyst, e.g., AIBN, to form the halo derivative (V). (V) is reacted in the presence of a Lewis acid, such as zinc chloride, with an aromatic or heteroaromatic compound to form the compound (VI). (VI) in turn is hydrolyzed and then reacted with alkylhaloformate, such as alkylchloroformate in the presence of a tertiary amine to generate the mixed N-acyl amino acid carbonic ester anhydride (VIII). This intermediate is reacted with an amine under amide forming conditions to give the compound of Formula I. Alternatively, (VI) can be reacted directly with an amine ( $RNH_2$ ) optionally in the presence of a metal catalyst, such as metal cyanides, e.g., potassium or sodium cyanide, under amide forming conditions to form a compound of Formula I. Alternatively, compound VIII can be prepared by an independent method and converted to VI which is then reacted with an amine, with or without catalyst to form the compound of Formula I.

**Scheme IV**



In the above scheme,  $R_9$  is lower alkyl,  $R_2$  is  $Z-Y$  and  $Z$ ,  $Y$ ,  $R_1$ ,  $R_2$  and  $R_3$  are as defined hereinabove.

The ether functionality on **IX** can be cleaved by treatment with Lewis acids, such as  $\text{BBr}_3$  in an inert solvent such as methylene chloride to form the corresponding halo (bromo) derivative. Addition of either an excess of the  $\text{H}-\text{R}_2$  or  $\text{MR}_2$  or the sequential addition of triethylamine and  $\text{H}-\text{R}_2$  to a THF mixture containing the halo derivative furnishes the desired product. For example, in the case wherein the

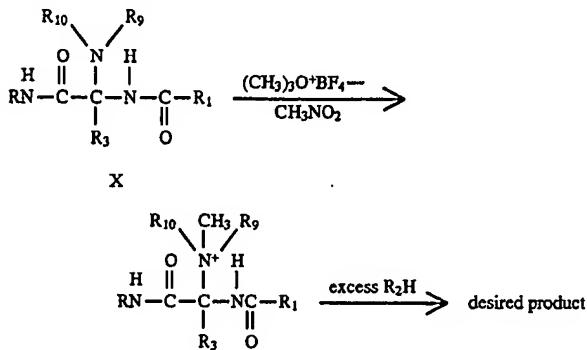


### compound of Formula L

compound of Formula IX is 2-acetamido-N-benzyl-2-ethoxy acetamide. its treatment with  $\text{BBr}_3$  in  $\text{CH}_2\text{Cl}_2$  led to the formation of the  $\alpha$ -bromo derivative, 2-acetamido-N-benzyl-2-bromoacetamide. Addition of an excess of  $\text{HR}_2$  or the sequential addition of  $\text{HR}_2$  to a THF mixture containing the bromo adduct furnishes the desired product.

In another procedure, the product wherein  $\text{R}_2$  or  $\text{R}_3$  is  $\text{Z}-\text{Y}$  can also be prepared by substitution reaction on a quaternary ammonium derivative of the compound of Formula I as outlined below

Scheme VI



In scheme VI,  $\text{R}$ ,  $\text{R}_1$ ,  $\text{R}_3$  and  $\text{R}$  are as defined hereinabove,  $\text{R}_2$  is  $\text{Z}-\text{Y}$  and  $\text{R}_9$  and  $\text{R}_{10}$  are independently lower alkyl. In scheme VI, methylation of compound X with a methylation reagent, such as trimethyloxonium tetrafluoroborate provided the corresponding ammonium derivative. Subsequent treatment of the ammonium salt with  $\text{HR}_2$  furnishes the desired product. For example, methylation of 2-acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide with trimethyloxonium tetrafluoroborate in nitromethane furnished the quaternary ammonium derivative, 2-acetamido-N-benzyl-(N,N,N-trimethylammonium) acetamide tetrafluoroborate in high yields. Subsequent treatment of the salt with the  $\text{HR}_2$  reagent in the methanol leads to the production of the desired product.

As in any organic reaction, solvents can be employed such as methanol, ethanol, propanol, acetone, tetrahydrofuran, dioxane, dimethylformamide, dichloromethane, chloroform, and the like. The reaction is normally effected at or near room temperature, although temperatures from  $0^\circ \text{C}$ . up to the reflux temperature of the reaction mixture can be employed.

As a further convenience, the amide forming reaction can be effected in the presence of a base, such as tertiary organic amine, e.g., triethylamine, pyridine, 4-methylmorpholine, picolines and the like, particularly where hydrogen halide is formed by the amide forming reaction, e.g., the reaction acyl halide and the amine of Formula II. Of course, in those reactions where hydrogen halide is produced, any of the commonly used hydrogen halide acceptors can also be used.

The exact mineral acid or Lewis acid employed in the reaction will vary depending on the given transformation, the temperature required for the conversion and the sensitivity of the reagent toward the acid in the reaction employed.

Compounds of the present invention in which  $\text{Q}$  or  $\text{A}$  is  $\text{S}$  are prepared from the corresponding compounds in which  $\text{Q}$  or  $\text{A}$  is  $\text{O}$  by art recognized techniques. For example, one reagent that can be used is Lawesson's reagent, i.e., [2,4-bis-(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane-2,4-disulfide]. This reagent is a known reagent for the thiation of such compounds as ketones, carboxamides, esters, lactones,

lactams, imides, enamines, and S-substituted thioesters. Thus, this reagent can be used to transform compounds of Formula I wherein  $\text{Q}$  or  $\text{A}$  is  $\text{O}$  to compounds wherein one or both of  $\text{Q}$  or  $\text{A}$  is  $\text{S}$ . The number of



groups in the final product is dependent upon the amount of reagent added and the number of



groups present (i.e., the value of  $n$ ) in the reactants having Formula I. For example, if  $n$  is 1, and both  $\text{Q}$  and  $\text{A}$  are oxygen, than the compounds of Formula I have two



groups. Thus, if it is desired that both



groups be transformed to



then approximately equimolar amount or a slight excess of is added to compounds of Formula I. On the other hand, if only one



group is desired in the final product, then approximately  $\frac{1}{2}$  molar equivalent of Lawesson's reagent is used.

Furthermore, it is not necessary to add the reagent at the last step of the synthesis; the reagent can be added at any stage of the syntheses outlined in Schemes I-VI hereinabove. As before, the amount of the reagent added depends upon the number of



desired in the product, and the number of



groups in the reactant.

Regardless of which step in the synthesis the reagent is added, the reagent and the compound of Formula I having at least one



group or an intermediate thereof is dissolved in an inert solvent, such as THF and heated at a temperature effective to convert the



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group to



Temperatures ranging from room temperature to the reflux temperature of the solvent can be used. In cases when  $n=1$ , it is preferred that the reaction is heated to about reflux if both Q and A are converted to S and that about room temperature be used if one of Q or A is converted to S.

The various substituents on the present new compounds, e.g., as defined in R, R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> can be present in the starting compounds, added to any one of the intermediates or added after formation of the final products by the known methods of substitution or conversion reactions. For example, the nitro groups can be added to the aromatic ring by nitration and the nitro group converted to other groups, such as amino by reduction, and halo by diazotization of the amino group and replacement of the diazo group. Alkanoyl groups can be substituted onto the aryl groups by Friedel-Crafts acylation. The acyl groups can be then transformed to the corresponding alkyl groups by various methods, including the Woff-Kishner reduction and Clemmenson reduction. Amino groups can be alkylated to form mono, dialkylamino and trialkylamino groups; and mercapto and hydroxy groups can be alkylated to form corresponding thioethers or ethers, respectively. Primary alcohols can be oxidized by oxidizing agents known in the art to form carboxylic acids or aldehydes, and secondary alcohols can be oxidized to form ketones. Thus, substitution or alteration reactions can be employed to provide a variety of substituents throughout the molecule of the starting material, intermediates, or the final product.

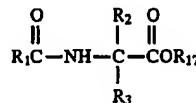
In the above reactions, if the substituents themselves are reactive, then the substituents can themselves be protected according to the techniques known in the art. A variety of protecting groups known in the art may be employed. Examples of many of these possible groups may be found in "Protective Groups in Organic Synthesis," by T. W. Greene, John Wiley & Sons, 1981.

Resulting mixtures of isomers can be separated in the pure isomers by methods known to one skilled in the art, e.g., by fractional distillation, crystallization and/or chromatography.

The present compounds obviously exist in stereoisomeric forms and the products obtained thus can be mixtures of the isomers, which can be resolved. Optically pure functionalized amino acid derivatives can be prepared directly from the corresponding pure chiral intermediate. Racemic products can likewise be resolved into the optical antipodes, for example, by separation of diastereomeric salts thereof, e.g., by fractional crystallization, by selective enzymatic hydrolysis, e.g., papain digestion, or by use of a chiral stationary phase in chromatography (HPLC). For a discus-

sion of chiral stationary phases for HPLC, See, DeCamp, *Chirality*, 1, 2-6 (1989), which is incorporated herein by reference with the same force and effect as if fully set forth herein.

5 For example, a racemic mixture of any of the intermediate in any of the schemes, e.g.,



wherein R<sub>17</sub> is H (which can be prepared according to the procedures of Schemes 1, 2, 3 or 4) is reacted with an

15 optically active amine, RNH<sub>2</sub>, e.g., (R)(+)-α-methylbenzylamine to form a pair of diastereomeric salts. Diastereomers can then be separated by recognized techniques known in the art, such as fractional recrystallization and the like.

20 In another method, a racemic mixture of final products or intermediates can be resolved by using enzymatic methods. Since enzymes are chiral molecules, it can be used to separate the racemic modification, since it will preferentially act on one of the compounds, without affecting the enantiomer.

25 For example, acylase, such as acylase I, can be used to separate the racemic modification of an intermediate D,L(±)-α-acetamido-2-furanacetic acid. It acts on the L(±)-α-acetamido-2-furanacetic acid, but will not act on the D enantiomer. In this way, the D(-)-α-acetamido-2-furanacetic acid can be isolated. The intermediate can then react with the amine (RNH<sub>2</sub>) under amide forming conditions as described hereinabove to form the compound of Formula I.

The active ingredients of the therapeutic compositions and the compounds of the present invention exhibit excellent anticonvulsant activity when administered in amounts ranging from about 10 mg to about 100 mg per kilogram of body weight per day. A preferred dosage regimen for optimum results would be from about 20 mg to about 50 mg per kilogram of body weight per day, and such dosage units are

35 employed that a total of from about 1.0 gram to about 3.0 grams of the active compound for a subject of about 70 kg of body weight are administered in a 24-hour period. This dosage regimen may be adjusted to provide the optimum therapeutic response and is preferably administered one to 40 three times a day in dosages of about 600 mg per administration. For example, several divided doses may be administered daily or the dose may be proportionally reduced as indicated by the exigencies of the therapeutic situation. A decided practical advantage is that the active compound may be administered in an convenient manner such as by the oral, intravenous (where water soluble), intramuscular or subcutaneous routes.

45 The active compound may be orally administered, for example, with an inert diluent or with an assimilable edible carrier, or it may be enclosed in hard or soft shell gelatin capsules, or it may be compressed into tablets, or it may be incorporated directly with the food of the diet. For oral therapeutic administration, the active compound may be incorporated with excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. Such compositions and preparations should contain at least 1% of active compound. The percentage of the compositions and preparations may, of course, be varied and may conveniently be between

50 about 5 to about 80% of the weight of the unit. The amount of active compound in such therapeutically useful compositions is such that a suitable dosage will be obtained.

Preferred compositions or preparations according to the present invention are prepared so that an oral dosage unit form contains between about 5 and 1000 mg of active compound.

The tablets, troches, pills, capsules and the like may also contain the following: A binder such as gum tragacanth, acacia, corn starch or gelatin; excipients such as dicalcium phosphate; a disintegrating agent such as corn starch, potato starch, alginic acid and the like; a lubricant such as magnesium stearate; and a sweetening agent such as sucrose, lactose or saccharin may be added or a flavoring agent such as peppermint, oil of wintergreen, or cherry flavoring. When the dosage unit form is a capsule, it may contain, in addition to materials of the above type, a liquid carrier. Various other materials may be present as coatings or to otherwise modify the physical form of the dosage unit. For instance, tablets, pills, or capsules may be coated with shellac, sugar or both. A syrup or elixir may contain the active compound, sucrose as a sweetening agent, methyl and propylparabens as preservatives, a dye and flavoring such as cherry or orange flavor. Of course, any material used in preparing any dosage unit form should be pharmaceutically pure and substantially non-toxic in the amounts employed. In addition, the active compound may be incorporated into sustained-release preparations and formulations. For example, sustained release dosage forms are contemplated wherein the active ingredient is bound to an ion exchange resin which, optionally, can be coated with a diffusion barrier coating to modify the release properties of the resin.

The active compound may also be administered parenterally or intraperitoneally. Dispersions can also be prepared in glycerol, liquid polyethylene glycols, and mixtures thereof and in oils. Under ordinary conditions of storage and use, these preparations contain a preservative to prevent the growth of microorganisms.

The pharmaceutical forms suitable for injectable use include sterile aqueous solutions (where water soluble) or dispersions and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersions. In all cases the form must be sterile and must be fluid to the extent that easy syringability exists. It must be stable under the conditions of manufacture and storage and must be preserved against the contaminating action of microorganisms such as bacteria and fungi. The carrier can be a solvent or dispersion medium containing, for example, water, ethanol, polyol (for example, glycerol, propylene glycol, and liquid polyethylene glycol, and the like), suitable mixtures thereof, and vegetable oils. The proper fluidity can be maintained, for example, by the use of a coating such as lecithin; by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. The prevention of the action of microorganisms can be brought about by various antibacterial and antifungal agents, for example, parabens, chlorobutanol, phenol, sorbic acid, thimerosal, and the like. In many cases, it will be preferable to include isotonic agents, for example, sugars or sodium chloride. Prolonged absorption of the injectable compositions can be brought about by the use in the compositions of agents delaying absorption, for example, aluminum monostearate and gelatin.

Sterile injectable solutions are prepared by incorporating the active compound in the required amount in the appropriate solvent with various of the other ingredients enumerated above, as required, followed by filtered sterilization. Generally, dispersions are prepared by incorporating the various sterilized active ingredient into a sterile vehicle which contains the basic dispersion medium and the

required other ingredients from those enumerated above. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation are vacuum drying and the freeze-drying technique which yield a powder of the active ingredient plus any additional desired ingredient from previously sterile-filtered solution thereof.

As used herein, "pharmaceutically acceptable carrier" includes any and all solvents, dispersion media, coatings, 10 antibacterial and antifungal agents, isotonic and absorption delaying agents, and the like. The use of such media and agents for pharmaceutical active substances is well known in the art. Except insofar as any conventional media or agent is incompatible with the active ingredient, its use in the therapeutic compositions is contemplated. Supplementary active ingredients can also be incorporated into the compositions.

It is especially advantageous to formulate parenteral compositions in dosage unit form for ease of administration and uniformity of dosage. Dosage unit form as used herein refers 15 to physically discrete units suited as unitary dosages for the mammalian subjects to be treated; each unit containing a predetermined quantity of active material calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. The specification for the 20 novel dosage unit forms of the invention are dictated by and directly dependent on (a) the unique characteristics of the active material and the particular therapeutic effect to be achieved, and (b) the limitations inherent in the art of compounding such an active material for the treatment of 25 disease in living subjects having a diseased condition in which bodily health is impaired as herein disclosed in detail.

The principal active ingredient is compounded for convenient and effective administration in effective amounts with a suitable pharmaceutically acceptable carrier in dosage 30 unit form as hereinbefore disclosed. A unit dosage form can, for example, contain the principal active compound in amounts ranging from about 5 to about 1000 mg, with from about 250 to about 750 mg being preferred. Expressed in proportions, the active compound is generally present in 35 from about 10 to about 750 mg/ml of carrier. In the case of 40 compositions containing supplementary active ingredients, the dosages are determined by reference to the usual dose and manner of administration of the said ingredients.

The compounds of the present invention may be administered 45 in combination with other anti-convulsant agents, such as phenytoin, phenobarbital, mephenytoin, and phenacemide, and the like. This combination is likely to exhibit synergistic effects.

For a better understanding of the present invention 50 together with other and further objects, reference is made to the following description and examples.

#### General Methods.

Melting points were determined with a Thomas-Hoover melting point apparatus and are uncorrected. Infrared spectra (IR) were run on a Beckman IR-4250 and Perkin-Elmer 55 1330 and 283 spectrophotometers and calibrated against the 1601-cm<sup>-1</sup> band of polystyrene. Absorption values are expressed in wavenumbers (cm<sup>-1</sup>). Proton nuclear magnetic resonance (<sup>1</sup>H NMR) spectra were recorded on Varian 60 Associates Models T-60 and FT-80A, General Electric QE 300, and Nicolet NT-300 NMR spectrometers. Carbon nuclear magnetic resonance (<sup>13</sup>C NMR) spectra were run on a Varian Associates Models FT-80A General Electric QE 300 and Nicolet NT-300 instrument. Chemical shifts are in 65 parts per million ( $\delta$  values) relative to Me<sub>4</sub>Si, and coupling constants (J values) are in hertz. Mass spectral data were obtained at an ionizing voltage of 70 eV on a Hewlett-

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Packard 5930 gas chromatograph-mass spectrometer and a Bell-Howell 21-491 spectrometer as well as at the Eli Lilly Laboratories on a Varian MAT-CH-5 spectrometer. High-resolution (EI mode) mass spectra were performed by Drs. James Hudson and John Chinn at the Department of Chemistry, University of Texas at Austin, on a CEC21-110B double-focusing magnetic-sector spectrometer at 70 eV. Elemental analyses were obtained at Spang Microanalytical Laboratories, Eagle Harbor, Mich. and at the Eli Lilly Research Laboratories.

The solvents and reactants were of the best commercial grade available and were used without further purification unless noted. All anhydrous reactions were run under nitrogen, and all glassware was dried before use. In particular, acetonitrile and triethylamine were distilled from  $\text{CaH}_2$ , while dichloromethane was distilled from  $\text{P}_2\text{O}_5$ . Acetic anhydride, benzaldehyde and ethyl chloroformate were fractionally distilled.

Preparation of N-Acetyl-D- and L-amino acid-N-benzylamides.

## General Procedure.

The D- or L-amino acid amide (11 mmol) was dissolved in dichloromethane (15 mL) and then acetic anhydride (1.23 g, 1.40 mL, 12 mmol) was added dropwise. The solution was stirred at room temperature (18 h) and then concentrated to dryness. The residue was recrystallized from chloroform/hexane. The following examples 1-7 were prepared according to this procedure.

## EXAMPLE 1

## Preparation of N-Acetyl-D,L-alanine-N'-benzylamide.

Acetic anhydride (2.20 g, 0.022 mol) was slowly added to a methylene chloride solution (30 mL) of D,L-alanine-N-benzylamide (3.80 g, 0.021 mol) and allowed to stir at room temperature (3 h). The mixture was then successively washed with  $\text{H}_2\text{O}$  (15 mL), 1% aqueous NaOH (15 mL) and  $\text{H}_2\text{O}$  (15 mL), dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated in vacuo. The residue was recrystallized from  $\text{CH}_2\text{Cl}_2$ .

Yield: 2.50 g (54%).

mp 139°-141° C.

$^1\text{H}$  NMR (DMSO- $d_6$ ):  $\delta$  1.22 (d,  $J=7.1$  Hz, 3H), 1.84 (s, 3H), 4.04-4.50 (m, 3H), 7.26 (s, 5H), 8.11 (br d,  $J=7.3$  Hz, 1H), 8.42 (br t,  $J=6$  Hz, 1H).

$^{13}\text{C}$  NMR (DMSO- $d_6$ ): 18.2, 22.4, 41.9, 48.2, 126.5, 126.9, 128.1, 139.4, 168.9, 172.4 ppm.

IR ( $\text{CHCl}_3$ ) 3440, 3300, 3005, 1660, 1515  $\text{cm}^{-1}$ .

Mass spectrum (CI mode), m/e: 221 (P+1); mol wt 220.1208 (Calculated for  $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_2$ , 220.1212).

## EXAMPLE 2

## N-Acetyl-D-alanine-N'-benzylamide.

Yield: 1.36 g (56%).

mp 139°-141° C.

$[\alpha]_D^{25} = +36.2$  (c 2.5, MeOH).

$^1\text{H}$  NMR (80 MHz, DMSO- $d_6$ ):  $\delta$  1.25 (d,  $J=7.1$  Hz, 3H), 1.86 (s, 3H), 4.10-4.50 (m, 1H), 4.30 (d,  $J=6.0$  Hz, 2H), 7.26 (s, 5H), 8.09 (d,  $J=7.3$  Hz, 1H), 8.40 (t,  $J=6.0$  Hz, 1H).

$^{13}\text{C}$  NMR (80 MHz, DMSO- $d_6$ ): 18.3, 22.5, 42.0, 48.4, 126.6, 127.0 (2C), 128.2 (2C), 139.4, 169.2, 172.5 ppm.

IR (KBr): 3290, 1635 (br), 1540, 1455, 700, 695  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 221 (30), 114 (20), 106 (40), 91 (80), 87 (100), 77 (5), 72 (20), 65 (5).

Elemental analysis Calculated for  $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_2$  65.42% C; 7.34% H; 12.72% N. Found 65.31% C; 7.28% H; 12.63% N.

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## EXAMPLE 3

## N-Acetyl-L-alanine-N'-benzylamide.

Yield: 1.11 g (46%).

mp 139°-142° C.

$[\alpha]_D^{25} = -35.3$  (c 2.5, MeOH).

$^1\text{H}$  NMR (80 MHz, DMSO- $d_6$ ):  $\delta$  1.23 (d,  $J=7.2$  Hz, 3H), 1.86 (s, 3H), 4.26-4.35 (m, 1H), 4.29 (d,  $J=5.8$  Hz, 2H), 7.22-7.33 (s, 5H), 8.10 (d,  $J=7.4$  Hz, 1H), 8.42 (t,  $J=5.8$  Hz, 1H).

$^{13}\text{C}$  NMR (80 MHz, DMSO- $d_6$ ): 18.3, 22.6, 42.0, 48.4, 126.7, 127.0 (2C), 128.3 (2C), 139.5, 169.2, 172.6 ppm.

IR (KBr): 3290, 1635 (br), 1545, 1450, 700, 695  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 221 (40), 114 (40), 106 (80), 106 (80), 91 (75), 87 (100), 77 (5), 72 (15), 65 (5).

Elemental analysis Calculated for  $\text{C}_{12}\text{H}_{16}\text{N}_2\text{O}_2$  65.42% C; 7.34% H; 12.72% N. Found 65.58% C; 7.32% H; 12.43% N.

## EXAMPLE 4

## Preparation of N-Acetyl-D,L-phenylglycine-N'-methylamide.

Acetic anhydride (2.90 g, 28 mmol) was added dropwise to D,L-phenylglycine-N-methylamide (3.4 g, 20 mmol) and allowed to stir at room temperature (1.5 h). During this time, a copious white precipitate formed. This material was collected by filtration, dried in vacuo and recrystallized from absolute alcohol.

Yield: 2.00 g (49%).

mp 232°-235° C. (dec).

$^1\text{H}$  NMR (DMSO- $d_6$ ):  $\delta$  1.89 (s, 3H), 2.58 (d,  $J=4.6$  Hz, 3H), 5.42 (d,  $J=8.1$  Hz, 1H), 7.35 (s, 5H), 8.18 (br q,  $J=4.2$  Hz, 1H), 8.47 (d,  $J=8.1$  Hz, 1H).

$^{13}\text{C}$  NMR (DMSO- $d_6$ ): 22.4, 25.5, 56.3, 127.1, 127.3, 128.1, 139.0, 168.9, 170.3 ppm.

IR (KBr): 3310, 1645  $\text{cm}^{-1}$ .

Mass spectrum (CI mode), m/e: 207 (P+1).

Elemental analysis Calculated for  $\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}_2$  64.06% C; 6.86% H; 13.58% N. Found 63.79% C; 6.66% H; 13.27% N.

## EXAMPLE 5

## Preparation of N-Acetylglycine-N'-benzylamide.

The D,L-amino acid amide (11 mmol) was dissolved in dichloromethane (15 mL) and then acetic anhydride (1.23 g, 1.40 mL, 12 mmol) was added dropwise. The solution was stirred at room temperature (4-6 h) and then concentrated to dryness. The residue was recrystallized from chloroform/hexane.

Yield: 1.84 g (81%).

mp 140°-142° C.

$^1\text{H}$  NMR (DMSO- $d_6$ ):  $\delta$  1.88 (s, 3H), 3.74 (d,  $J=5.3$  Hz, 2H), 4.30 (d,  $J=5.1$  Hz, 2H), 7.27 (s, 5H), 8.37 (br s, 1H), 8.75 (br s, 1H).

$^{13}\text{C}$  NMR (DMSO- $d_6$ ): 22.5, 42.0, 42.5, 126.6, 127.1 (2C), 128.1 (2C), 139.3, 169.0, 169.6 ppm.

IR (KBr): 3060, 1655, 1640, 1560, 1545, 1450, 1300, 740, 710  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 206 (3), 147 (12), 106 (100), 91 (75), 73 (50).

Elemental analysis Calculated for  $\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}_2$  64.05% C; 6.86% H; 13.58% N. Found 64.03% C; 6.79% H; 13.61% N.

## EXAMPLE 6

Preparation of N-Acetyl-D,L-valine-N-benzylamide.

The D,L-amino acid amide (11 mmol) was dissolved in dichloromethane (15 mL) and then acetic anhydride (1.23 g, 1.40 mL, 12 mmol) was added dropwise. The solution was stirred at room temperature (4–6 h) and then concentrated to dryness. The residue was recrystallized from chloroform/hexane.

Yield: 2.35 g (86%).

mp 192°–193° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 0.83 (d, J=6.7 Hz, 6H), 1.87 (s, 3H), 1.73–2.09 (m, 1H), 4.11 (d, J=8.8 Hz, 1H), 4.27 (d, J=5.8 Hz, 2H), 7.26 (s, 5H), 7.89 (d, J=8.8 Hz, 1H), 8.84 (t, J=5.8 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 18.1, 19.2, 22.4, 30.2, 41.9, 57.8, 126.6, 127.1 (2C), 128.1 (2C), 139.4, 169.2, 171.1 ppm.

IR (KBr): 1625, 1540, 1535, 1450, 1380, 1290, 750, 695 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 142 (16), 114 (43), 106 (29), 91 (57), 72 (100).

Elemental analysis Calculated for C<sub>14</sub>H<sub>20</sub>N<sub>2</sub>O<sub>2</sub> 67.70% C; 8.13% H; 11.28% N. Found 67.58% C; 8.05% H; 11.10% N.

## EXAMPLE 7

Preparation of N-Acetyl-D,L-phenylglycine-N-benzylamide.

The D,L-amino acid amide (11 mmol) was dissolved in dichloromethane (15 mL) and then acetic anhydride (1.23 g, 1.40 mL, 12 mmol) was added dropwise. The solution was stirred at room temperature (4–6 h) and then concentrated to dryness. The residue was recrystallized from chloroform/hexane.

Yield: 2.05 g (66%).

mp 202°–203° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.91 (s, 3H), 4.27 (d, J=5.6 Hz, 2H), 5.50 (d, J=7.9 Hz, 1H), 7.21 (s, 5H), 7.36 (s, 5H), 8.38–8.86 (m, 2H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 22.3, 42.0, 56.3, 126.6 (2C), 127.0, 127.1 (2C), 127.4 (2C), 128.1 (2C), 138.9, 139.0, 168.9, 169.9 ppm.

IR (KBr): 3020, 1635, 1580, 1540, 1450, 1265, 745, 690 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 283 (20), 264 (21), 149 (100), 131 (20), 118 (34), 106 (92), 91 (70), 79 (56), 77 (54), 65 (45), 51 (37).

Elemental analysis Calculated for C<sub>17</sub>H<sub>18</sub>N<sub>2</sub>O<sub>2</sub> 72.31% C; 6.44% H; 9.92% N. Found 72.49% C; 6.47% H; 9.89% N.

Preparation of N-Acetyl-D- and L-phenylglycine-N-benzylamide.

General Procedure.

The chiral Boc-protected phenylglycine-N-benzylamide was dissolved in trifluoroacetic acid (0.04M) and was stirred at room temperature (30 min), during which time gas evolved. The solution was concentrated in vacuo and the residue was redissolved in enough methanol to form a solution of 0.2M. Methanesulfonic acid (1 equiv) was added dropwise and stirred for 5 min. After concentrating the solution in vacuo, the residue was repeatedly dissolved in methanol and the solvent was removed (3 times). The residue was then dried under vacuum (18 h), leaving a yellow oil.

Without further purification, the phenylglycine-N-benzylamide methanesulfonate was dissolved in tetrahydrofuran (0.2M) and then was cooled in an ice bath. Triethylamine (2 equiv) was added dropwise, followed by acetyl chloride (1 equiv). The ice bath was removed and stirring was continued at room temperature (18 h). The solution was concentrated in vacuo and the residue was recrystallized from 1:1 95% ethanol/water. Examples 8 and 9 were prepared according to this procedure.

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## EXAMPLE 8

N-Acetyl-D-phenylglycine-N-benzylamide.

The reaction was run on an 11.9 mmol scale.

Yield: 2.97 g (88%).

mp 219°–221° C.

[α]<sub>D</sub>=–103.0 (c 1%, EtOH).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.91 (s, 3H), 4.27 (d, J=5.5 Hz, 2H), 5.50 (d, J=7.8 Hz, 1H), 7.14–7.44 (m, 10H), 8.56 (d, J=7.8 Hz, 1H), 8.79 (t, J=5.5 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 22.4, 42.0, 56.4, 126.7, 127.0 (2C), 127.2 (2C), 127.4, 127.9 (2C), 128.1 (2C), 138.9, 139.0, 168.9, 170.0 ppm.

IR (KBr): 3260, 1620, 1525, 1450, 1370, 720, 690 cm<sup>–1</sup>.

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Mass spectrum, m/e (relative intensity): 203 (2), 149 (94), 106 (100), 91 (32), 86 (43), 77 (14).

Elemental analysis Calculated for C<sub>17</sub>H<sub>18</sub>N<sub>2</sub>O<sub>2</sub> 72.32% C; 6.43% H; 9.92% N. Found 72.04% C; 6.22% H; 9.78% N.

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## EXAMPLE 9

N-Acetyl-L-phenylglycine-N-benzylamide.

Beginning with 16.1 mmol N-t-Boc-L-phenylglycine-N-benzylamide.

Yield: 2.99 g (66%).

mp 221°–222° C.

[α]<sub>D</sub>=+105.1 (c 1%, EtOH).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.99 (s, 3H), 4.36 (d, J=5.6 Hz, 2H), 5.60 (d, J=8.0 Hz, 1H), 7.23–7.53 (m, 10H), 8.60 (d, J=8.0 Hz, 1H), 8.83 (t, J=5.6 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 22.4, 42.1, 56.5, 126.8, 127.1 (2C), 127.3 (2C), 127.5, 128.2 (4C), 139.0, 139.1, 169.1, 170.1 ppm.

IR (KBr): 3295, 1630, 1530, 1450, 1395, 720, 695 cm<sup>–1</sup>.

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Mass spectrum, m/e (relative intensity): 223 (1), 203 (2), 149 (98), 106 (100), 91 (32), 86 (43), 77 (11).

Elemental analysis Calculated for C<sub>17</sub>H<sub>18</sub>N<sub>2</sub>O<sub>2</sub> 72.32% C; 6.43% H; 9.92% N. Found 72.53% C; 6.49% H; 9.67% N.

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## EXAMPLE 10

Preparation of N-Acetyl-D,L-alanine-N-(3-methoxy)benzylamide.

The D,L-amino acid amide (11 mmol) was dissolved in dichloromethane (15 mL) and then acetic anhydride (1.23 g, 1.40 mL, 12 mmol) was added dropwise. The solution was stirred at room temperature (4–6 h) and then concentrated to dryness. The residue was recrystallized from chloroform/hexane.

Yield: 0.47 g (17%).

mp 112°–115° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.23 (d, J=7.1 Hz, 3H), 1.85 (s, 3H),

3.73 (s, 3H), 3.99–4.48 (m, 1H), 4.25 (d, J=6.1 Hz, 2H), 6.58–7.35 (m, 4H), 8.05 (d, J=7.4 Hz, 1H), 8.35 (t, J=6.0 Hz, 1H).

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<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 18.1, 22.5, 41.8, 48.3, 54.9, 112.2, 112.3, 119.0, 129.2, 141.0, 159.3, 169.0, 172.4 ppm.

IR (KBr): 3270, 3065, 1625, 1580, 1450, 1260, 1150, 1095, 900, 775, 700, 690 cm<sup>-1</sup>.

Elemental analysis Calculated for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub> 62.37% C; 7.26% H; 11.19% N. Found 62.29% C; 7.13% H; 11.08% N.

## EXAMPLE 11

Preparation of N-Trimethylacetyl-D,L-alanine-N-benzylamide.

D,L-Alanine-N-benzylamide (3.56 g, 20 mmol) was dissolved in dichloromethane (25 mL) and trimethylacetic anhydride (4.10 g, 4.46 mL, 22 mmol) was added dropwise. The solution was stirred at room temperature (18 h) and then concentrated to dryness. The solid residue was recrystallized from benzene/petroleum ether (30°–60° C.).

Yield: 2.07 g (40%).

mp 123°–124° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.12 (s, 9H), 1.27 (d,J=7.1 Hz, 3H), 4.23–4.42 (m, 1H), 4.31 (d,J=5.4 Hz, 2H), 7.23–7.30 (m, 5H), 7.38 (d,J=7.4 Hz, 1H), 8.26 (t,J=5.4 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 18.1, 27.2 (3C), 37.9, 42.0, 48.4, 126.6, 127.0 (2C), 128.2 (2C), 139.4, 172.5, 177.1 ppm.

IR (KBr): 3300, 1630, 1535 (br), 1455, 745, 695 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity): 262 (2), 203 (19), 156 (18), 128 (51), 106 (31), 91 (100), 77 (15), 65 (28).

Elemental analysis Calculated for C<sub>15</sub>H<sub>22</sub>N<sub>2</sub>O<sub>2</sub> 68.66% C; 8.47% H; 10.68% N. Found 68.91% C; 8.14% H; 10.61% N.

## EXAMPLE 12

Preparation of N-Acetyl-D,L-methionine-N-benzylamide.

N-Acetyl-D,L-methionine (4.78 g, 25 mmol) was combined with acetonitrile (75 mL) and the mixture was placed into an ice/salt water bath (~5° C.). Triethylamine (2.53 g, 3.48 mL, 25 mmol) was added dropwise, followed by ethyl chloroformate (2.71 g, 2.39 mL, 25 mmol). All additions were done slowly so that the temperature of the mixture did not rise above 0° C. The mixture was then stirred at ~5° C. (20 min). Benzylamine (3.00 g, 3.06 mL, 28 mmol) in acetonitrile (5 mL) was added dropwise and the mixture was stirred at ~5° C. (1 h) and then room temperature (18 h).

The mixture was filtered and a white precipitate was collected and dried in vacuo and identified as the desired product (<sup>1</sup>H NMR and <sup>13</sup>C NMR analyses). The filtrate was concentrated in vacuo and the residue was combined with hot tetrahydrofuran (50 mL) and cooled in the freezer (3 h), resulting in the formation of a white precipitate. The mixture was filtered and the precipitate was collected, dried in vacuo, and identified as triethylammonium hydrochloride.

The latter filtrate containing tetrahydrofuran was concentrated in vacuo and the resulting residue was purified by flash column chromatography (ethyl acetate). A white solid (R<sub>f</sub>=0.50, ethyl acetate) was isolated and was identified as the desired product (<sup>1</sup>H NMR and <sup>13</sup>C NMR analyses). The two solids identified as N-acetyl-D,L-methionine-N-benzylamide were combined and recrystallized from benzene/petroleum ether (30°–60° C.).

Yield: 2.98 g (43%).

mp 134°–135° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.69–1.94 (m, 2H), 1.87 (s, 3H), 2.02 (s, 3H), 2.29–2.59 (m, 2H), 4.10–4.53 (m, 1H), 4.29

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(d,J=6.0 Hz, 2H), 7.26 (s, 5H), 8.12 (d,J=8.5 Hz, 1H), 8.47 (t,J=6.0 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 14.6, 22.5, 29.7, 31.8, 42.0, 52.0, 126.6, 127.0 (2C), 128.2 (2C), 139.4, 169.5, 171.4 ppm.

IR (KBr): 3280, 1630, 1545, 1460, 750, 700 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity): 280 (3), 206 (100), 164 (29), 146 (20), 106 (54), 91 (76), 77 (14), 65 (24).

Elemental analysis Calculated for C<sub>14</sub>H<sub>20</sub>N<sub>2</sub>O<sub>2</sub>S 59.96% C; 7.20% H; 9.99% N. Found 60.02% C; 7.14% H; 9.91% N.

## EXAMPLE 13

Preparation of N-Acetylalanine-N-(3-fluoro)benzylamide.

N-Acetylalanine (3.28 g, 25 mmol) was combined with acetonitrile (100 mL) and the mixture was placed into an ice/salt bath at ~5° C. Triethylamine (2.53 g, 3.5 mL, 25 mmol) was added dropwise followed by the addition of ethyl chloroformate (2.71 g, 2.40 mL, 25 mmol). All additions were done slowly so that the temperature of the mixture did not rise above 0° C. The mixture was then stirred at ~5° C. for 20 minutes. 3-Fluorobenzylamine (3.58 g, 28 mmol) and acetonitrile (5 mL) was added dropwise and was stirred at ~5° C. for one hour and then at room temperature for 18 hours. The reaction became homogenous during this time interval.

The solution was concentrated in vacuo and the residue was combined with hot tetrahydrofuran (100 mL) and cooled in the freezer for 3 hours resulting in the formation of a white precipitate. The mixture was filtered and the precipitate was collected, dried in vacuo and identified as triethylammonium hydrochloride (3.51 g, mp 253°–257° C.). The filtrate was concentrated in vacuo and the resulting yellow solid was recrystallized from chloroform/diethyl ether.

Yield: 3.22 g (54%).

mp 120°–121° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.27 (d,J=7.1 Hz, 3H), 1.90 (s, 3H), 4.23–4.41 (m, 1H), 4.33 (d,J=6.1 Hz, 2H), 7.05–7.37 (m, 4H), 8.19 (d,J=7.1 Hz, 1H), 8.53 (t,J=6.1 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 17.9, 22.4, 41.5, 48.5, 113.3 (d,J=20.4 Hz), 113.5 (d,J=21.7 Hz), 122.8, 130.1 (d,J=7.9 Hz), 142.4 (d,J=7.4 Hz), 162.3 (d,J=243.6 Hz), 169.6, 172.8 ppm.

IR (KBr): 3280, 1645, 1545, 1450, 745, 680 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity): 238 (18), 151 (22), 124 (49), 114 (47), 109 (100), 87 (76), 72 (27).

Elemental analysis Calculated 60.48% C; 6.36% H; 11.76% N. Found 60.55% C; 6.32% H; 11.71% N.

## EXAMPLE 14

Preparation of D,L- $\alpha$ -Acetamido-N-benzyl-3-thiopheneacetamide.

D,L- $\alpha$ -Acetamido-3-thiopheneacetic acid (2.99 g, 15 mmol) was combined with acetonitrile (60 mL) and the mixture was placed into an ice/salt water bath (~5° C.). Triethylamine (1.51 g, 2.10 mL, 15 mmol) was added dropwise, followed by ethyl chloroformate (1.63 g, 1.43 mL, 15 mmol). All additions were done slowly so that the temperature of the mixture did not rise above 0° C. The mixture was then stirred at ~5° C. (20 min). Benzylamine (1.77 g, 1.80 mL, 16.5 mmol) in acetonitrile (10 mL) was added dropwise and the mixture was stirred at ~5° C. (1 h) and then room temperature (18 h). The mixture was concentrated in vacuo and the residue was combined with hot

tetrahydrofuran (50 mL) and cooled in the freezer (3 h), resulting in the formation of a white precipitate. The mixture was filtered and the precipitate was collected, dried in vacuo, and identified as triethylammonium hydrochloride ( $^1\text{H}$  NMR analysis). The filtrate was concentrated in vacuo and the resulting yellow solid was recrystallized from 1:1 95% ethanol/water.

Yield: 1.91 g (44%).

mp 198°–199° C.

$^1\text{H}$  NMR (DMSO- $d_6$ ):  $\delta$  1.91 (s, 3H), 4.29 (d,  $J$ =5.2 Hz, 2H), 5.61 (d,  $J$ =7.9 Hz, 1H), 7.15–7.50 (m, 3H), 8.55 (d,  $J$ =7.9 Hz, 1H), 8.74 (t,  $J$ =5.2 Hz, 1H).

$^{13}\text{C}$  NMR (DMSO- $d_6$ ): 22.3, 42.0, 52.5, 122.4, 126.1, 126.7, 127.0 (3C), 128.2 (2C), 139.0, 139.2, 169.0, 169.8 ppm.

IR (KBr): 3460, 1675, 1570, 1400, 720, 695  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 288 (2), 245 (3), 155 (88), 112 (100), 91 (31), 85 (17), 65 (7).

Elemental analysis Calculated for  $\text{C}_{15}\text{H}_{16}\text{N}_2\text{O}_2\text{S}$  62.48% C; 5.59% H; 9.71% N. Found 62.41% C; 5.47% H; 9.55% N.

#### EXAMPLE 15

Preparation of D,L- $\alpha$ -Acetamido-N-benzyl-2-thiopheneacetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (6.26 g, 25 mmol) was combined with dry ether (175 mL) and then boron trifluoride etherate (5.68 g, 5.0 mL, 40 mmol) was added dropwise, resulting in a homogeneous solution. After stirring a short time, a small amount of a yellow oil separated from the solution. Thiophene (8.41 g, 8.0 mL, 100 mmol) was then added dropwise via syringe and the reaction was stirred at room temperature (4 d). The mixture was cooled in an ice bath and cold aqueous saturated  $\text{NaHCO}_3$  (200 mL) was added and the aqueous layer was extracted with ethyl acetate (2×100 mL). The organic washings and the original ether layer were combined, dried ( $\text{Na}_2\text{SO}_4$ ), and concentrated in vacuo. The residue was purified by flash column chromatography, using 94:6 chloroform/methanol as an eluent ( $R_f$ =0.7 94:6 chloroform/methanol), and then recrystallized from benzene.

Yield: 2.67 g (37%).

mp 167°–169° C.

$^1\text{H}$  NMR (DMSO- $d_6$ ):  $\delta$  1.91 (s, 3H), 4.31 (d,  $J$ =6.0 Hz, 2H), 5.74 (d,  $J$ =7.9 Hz, 1H), 6.99–7.44 (m, 8H), 8.64 (d,  $J$ =7.9 Hz, 1H), 8.85 (t,  $J$ =6.0 Hz, 1H).

$^{13}\text{C}$  NMR (DMSO- $d_6$ ): 22.4, 42.3, 52.2, 125.6, 125.8, 126.6, 126.9, 127.3 (2C), 128.3 (2C), 139.0, 141.4, 169.2, 169.3 ppm.

Mass spectrum, m/e (relative intensity): 289 (2), 181 (6), 155 (100), 112 (100), 91 (100), 85 (34), 74 (24).

Elemental analysis Calculated for  $\text{C}_{15}\text{H}_{16}\text{N}_2\text{O}_2\text{S}$  62.48% C; 5.59% H; 9.71% N. Found 62.64% C; 5.73% H; 9.61% N.

#### EXAMPLE 16

Preparation of D,L- $\alpha$ -Acetamido-N-benzyl-2-furanacetamide.

N-Acetyl-D,L-2-(2-furyl)glycine (0.47 g, 2.56 mmol) was combined with acetonitrile (10 mL) and cooled to  $-5^\circ\text{C}$ . (ice/salt water bath). Triethylamine (0.26 g, 0.36 mL, 2.56 mmol) was then rapidly added and the mixture stirred at  $-5^\circ\text{C}$ . (3 min). Ethyl chloroformate (0.28 g, 0.25 mL, 2.56

mmol) was added dropwise between  $-4^\circ\text{C}$ . and  $-3^\circ\text{C}$ ., and the resulting suspension was stirred at  $-4^\circ\text{C}$ . (20 min), and then an acetonitrile solution (2 mL) of benzylamine (0.30 g, 0.31 mL, 2.82 mmol) was carefully added. During the addition of benzylamine the temperature of the solution did not go above  $0^\circ\text{C}$ . The mixture was stirred at  $-5^\circ\text{C}$ . (1 h) and at room temperature (18 h), and then concentrated in vacuo. The residue was then triturated with hot tetrahydrofuran (5 mL), cooled at  $-16^\circ\text{C}$ . (3 h), and the resulting white precipitate was filtered and identified as triethylamine hydrochloride ( $^1\text{H}$  NMR, 60 MHz,  $\delta$  1.00 ( $t, J$ =7.5 Hz,  $\text{CH}_3$ ), 2.82 ( $q, J$ =7.5 Hz,  $\text{CH}_2$ ), 3.83 (s, NH)). The filtrate was evaporated to dryness in vacuo and the resulting oil purified by flash chromatography (98:2 chloroform/methanol) to give 0.09 g (13%) of the desired product as a white solid:  $R_f$  0.30 (98:2 chloroform/methanol).

mp 178°–179° C.

$^1\text{H}$  NMR (300 MHz, DMSO- $d_6$ ):  $\delta$  1.90 (s,  $\text{CH}_3$ ), 4.31 (d,  $J$ =6.0 Hz,  $\text{CH}_2$ ), 5.58 (d,  $J$ =8.1 Hz,  $\text{CH}$ ), 6.27–6.33 (m,  $\text{C}_3'\text{H}$ ), 6.40–6.44 (m,  $\text{C}_4'\text{H}$ ), 7.20–7.36 (m, Ph), 7.60–7.64 (m,  $\text{C}_5'\text{H}$ ), 8.57 (d,  $J$ =8.1 Hz, NH), 8.73 ( $t, J$ =6.0 Hz, NH).

$^{13}\text{C}$  NMR (300 MHz, DMSO- $d_6$ ): 22.35 ( $\text{CH}_3$ ), 42.27 ( $\text{CH}_2$ ), 50.95 (CH), 107.60 ( $\text{C}_3'$ ), 110.55 ( $\text{C}_4'$ ), 126.82 ( $2\text{C}_2''$  or  $2\text{C}_3''$ ), 127.08 ( $2\text{C}_2''$  or  $2\text{C}_3''$ ), 128.27 ( $\text{C}_4''$ ), 139.05 ( $\text{C}_1''$ ), 142.58 ( $\text{C}_5''$ ), 151.16 ( $\text{C}_2'$ ), 168.02 ( $\text{CH}_3\text{CO}$ ), 169.30 (NHCO) ppm.

IR (KBr): 3230, 1625 (br), 1525 (br), 1375 (br), 1230, 1090, 890  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 273 (1), 139 (100), 96 (94), 91 (51), 65 (9).

Elemental analysis Calculated for  $\text{C}_{15}\text{H}_{16}\text{N}_2\text{O}_3$  66.16% C; 5.83% H; 10.29% N. Found 65.92% C; 5.83% H; 10.15% N.

#### EXAMPLE 17

Preparation of D,L- $\alpha$ -Acetamido-N-benzyl-2-pyrroleacetamide.

2-Acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol) was suspended in anhydrous ethyl ether (60 mL), and then boron trifluoride etherate (1.82 g, 1.57 mL, 12.8 mmol) was added in one portion and the resulting solution was stirred (15 min). The pyrrole (2.14 g, 2.22 mL, 32 mmol) was then added in one portion and the solution was stirred at room temperature (48 h) during which time a precipitate formed. Hexanes (80 mL) were then added to the suspension, and the mixture was filtered and the brown semi-solid was triturated with 95:5 chloroform/methanol (30 mL) to furnish a green solid. This material was purified by flash chromatography (95:5 chloroform/methanol) to yield 0.94 g (35%) of the desired product as a white solid:  $R_f$  0.29 (96:4 chloroform/methanol).

mp 174°–175° C.

$^1\text{H}$  NMR (300 MHz,  $\text{CD}_3\text{CN}$ ):  $\delta$  1.93 (s,  $\text{CH}_3$ ), 4.35 (d,  $J$ =6.0 Hz,  $\text{CH}_2$ ), 5.42 (d,  $J$ =6.9 Hz,  $\text{CH}$ ), 6.00–6.18 (m,  $\text{C}_3'\text{H}$ ,  $\text{C}_4'\text{H}$ ), 6.68–6.72 (m,  $\text{C}_5'\text{H}$ ), 7.04 (d,  $J$ =6.9 Hz, NH), 7.1.7 (t,  $J$ =6.0 Hz, NH), 7.10–7.47 (m, Ph), 9.10–9.80 (br s, NH).

$^{13}\text{C}$  NMR (300 MHz,  $\text{CD}_3\text{CN}$ ): 23.02 ( $\text{CH}_3$ ), 43.83 ( $\text{CH}_2$ ), 52.65 (CH), 107.57 ( $\text{C}_3'$ ), 108.85 ( $\text{C}_4'$ ), 119.33 ( $\text{C}_5'$ ), 127.96 ( $\text{C}_2'$ ), 128.01 ( $2\text{C}_2''$  or  $2\text{C}_3''$ ), 128.09 ( $2\text{C}_2''$  or  $2\text{C}_3''$ ), 129.49 ( $\text{C}_4''$ ), 140.01 ( $\text{C}_1''$ ), 170.94 ( $\text{COCH}_3$ ), 171.21 (CONH) ppm.

IR (KBr): 3320, 1570 (br), 1470 (br), 1330, 1230, 950, 890, 860, 760, 710, 690, 655  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity): 171 (12), 228 (2), 213 (1), 180 (2), 164 (9), 137 (93), 108 (20), 95 (100), 91 (38), 82 (35), 68 (15).

High resolution mass spectral analysis Calculated for C<sub>15</sub>H<sub>17</sub>N<sub>3</sub>O<sub>2</sub> 271.13208. Found 271.13144.

#### EXAMPLE 18

##### Preparation of D,L-2-Acetamido-N-benzyl-2-ethoxyacetamide.

An ethanolic solution (420 mL) of ethyl 2-acetamido-2-ethoxyacetate (27.92 g, 147 mmol) and benzylamine (23.70 g, 24 mL, 221 mmol) was stirred at 40°–45° C. for 3 days. The reaction mixture was evaporated in vacuo and the residue recrystallized (1:3.5 tetrahydrofuran/hexanes (650 mL)) to yield 25.80 g (70%) of the desired product as beige crystals: R<sub>f</sub> 0.59 (95:5 chloroform/methanol).

mp 153°–155° C.

<sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ 1.20 (t, J=7.0 Hz, CH<sub>3</sub>), 2.07 (s, CH<sub>3</sub>), 3.60–3.76 (m, CH<sub>2</sub>CH<sub>3</sub>), 4.40–4.54 (m, CH<sub>2</sub>NH), 5.60 (d, J=8.7 Hz, CH), 6.63 (d, J=8.7 Hz, NH), 7.00 (br s, NH), 7.26–7.36 (m, Ph).

<sup>13</sup>C NMR (300 MHz, CDCl<sub>3</sub>): 15.06 (CH<sub>3</sub>CH<sub>2</sub>), 23.25 (CH<sub>3</sub>CO), 43.60 (CH<sub>2</sub>NH), 64.51 (CH<sub>2</sub>CH<sub>3</sub>), 77.43 (CH), 127.69 (2C<sub>2</sub> or 2C<sub>3</sub>, C<sub>4</sub>), 128.79 (2C<sub>2</sub> or 2C<sub>3</sub>), 137.57 (C<sub>1</sub>), 168.13 (COCH<sub>3</sub>), 171.29 (CONH) ppm.

IR (KBr): 3260, 1630 (br), 1550 (sh), 1505 (br), 1380, 1360, 1230, 1115, 1060, 1015, 890, 745, 690 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 251 (4), 163 (9), 116 (98), 106 (34), 91 (98), 74 (100).

Elemental analysis Calculated for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub> 62.38% C; 7.25% H; 11.19% N. Found 62.49% C; 7.27% H; 11.24% N.

#### EXAMPLE 19

##### Preparation of D,L-2-Acetamido-N-benzyl-2-methoxyacetamide.

To a methanolic solution (180 mL) of methyl 2-acetamido-2-methoxyacetate (8.73 g, 54 mmol) was rapidly added benzylamine (8.68 g, 8.80 mL, 81 mmol) and then the mixture was stirred at 50° C. (3 days) during which time a beige precipitate appeared. The solvent was removed in vacuo and the resulting precipitate was recrystallized from tetrahydrofuran (2x) to give 7.67 g (32%) of the desired product as beige crystals: R<sub>f</sub> 0.35 (95:5 chloroform/methanol).

mp 145°–146° C.

<sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ 2.06 (s, CH<sub>3</sub>CO), 3.37 (s, CH<sub>2</sub>O), 4.40–4.35 (m, CH<sub>2</sub>), 5.52 (d, J=8.7 Hz, CH), 7.12 (d, J=8.7 Hz, NH), 7.20–7.40 (m, Ph, NH).

<sup>13</sup>C NMR (300 MHz, CDCl<sub>3</sub>): 23.03 (CH<sub>3</sub>CO), 43.51 (CH<sub>2</sub>), 55.84 (CH<sub>2</sub>O), 78.94 (CH), 127.62 (C<sub>4</sub>), 127.70 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.70 (2C<sub>2</sub> or 2C<sub>3</sub>), 137.45 (C<sub>1</sub>), 166.91 (COCH<sub>3</sub>), 171.57 (CONH) ppm.

IR (KBr): 1260, 1825 (br), 1550, 1505, 1435, 1390, 1370, 1230, 1120, 1050, 935, 890, 690 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 237 (1), 205 (2), 177 (2), 163 (4), 146 (1), 134 (1), 121 (2), 106 (26), 102 (98), 91 (95), 77 (13), 61 (100).

Elemental analysis Calculated for C<sub>12</sub>H<sub>16</sub>N<sub>2</sub>O<sub>3</sub> 61.00%. C; 6.83% H; 11.86% N. 60.91% C; 6.85% H; 11.66% N.

#### EXAMPLE 20

##### Preparation of (D,L)- $\alpha$ -Acetamido-N-benzyl-2-(5-methylfuran)acetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (2.00 g, 8.0 mmol) was suspended in anhydrous ethyl ether, and then

boron trifluoride etherate (1.82 g, 12.8 mmol) was rapidly added, and the resulting solution was stirred for 15 min. The 2-methylfuran (2.63 g, 32.0 mmol) was then added and the reaction was stirred at room temperature (3 d). The reaction mixture was poured into an aqueous saturated NaHCO<sub>3</sub> solution and extracted with ethyl acetate (3x). The ethyl acetate extracts were combined, dried (Na<sub>2</sub>SO<sub>4</sub>) and evaporated in vacuo to give a beige solid, which was purified by flash chromatography (98:2 chloroform/methanol) to give the desired product as a white crystalline solid.

Yield: 1.40 g (61%).

R<sub>f</sub> 0.25 (98:2 chloroform/methanol).

mp 148°–150° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.88 (s, CH<sub>3</sub>CO), 2.23 (s, CH<sub>3</sub>), 4.24–4.36 (m, CH<sub>2</sub>), 5.49 (d, J=8.0 Hz, CH), 6.01 (br s, C<sub>3</sub>H), 6.14 (d, J=2.4 Hz, C<sub>4</sub>H), 7.20–7.31 (m, Ph), 8.52 (d, J=8.0 Hz, NH), 8.69 (t, J=5.6 Hz, NH).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 13.44 (CH<sub>3</sub>), 22.35 (CH<sub>3</sub>CO), 44.11 (CH<sub>2</sub>), 53.23 (CH), 107.51 (C<sub>3</sub> or C<sub>4</sub>), 110.40 (C<sub>3</sub> or C<sub>4</sub>), 128.13 (C<sub>4</sub>), 128.18 (2C<sub>2</sub> or 2C<sub>3</sub>), 129.43 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.69 (C<sub>1</sub>), 149.18 (C<sub>2</sub> or C<sub>5</sub>), 153.81 (C<sub>2</sub> or C<sub>5</sub>), 170.78 (CH<sub>3</sub>CO), 173.03 (CONH) ppm.

IR (KBr): 3270, 1620 (br), 1520 (br), 1440, 1360, 1210, 1010 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 286 (3), 179 (8), 153 (57), 152 (57), 111 (23), 110 (100), 97 (23), 91 (31).

Elemental Analysis Calculated: 67.12% C; 6.34% H; 9.78% N. Found: 66.92% C; 6.52% H; 9.52% N.

#### EXAMPLE 21

##### Preparation of (D,L)- $\alpha$ -Acetamido-N-benzyl-2-benzofuranacetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (1.00 g, 4 mmol) was suspended in anhydrous ethyl ether (30 mL) and then boron trifluoride etherate (0.91 g, 63 mmol) was rapidly added, and the resulting solution was stirred for 15 min. The benzofuran (1.89 g, 16 mmol) was then added and the reaction was stirred at room temperature (3 d). The reaction mixture was poured into an ice-cold saturated aqueous solution of NaHCO<sub>3</sub>, and then the mixture was maintained at this temperature for an additional 15 min. The mixture was extracted with ethyl acetate (2x), and the organic layers were combined, dried (Na<sub>2</sub>SO<sub>4</sub>) and evaporated in vacuo. The residue was purified by flash chromatography (100% chloroform, then 99:1 chloroform/methanol) to yield the desired product.

Yield: 0.43 g (33%).

R<sub>f</sub> 0.30 (98:2 chloroform/methanol).

mp 195°–196° C.;

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ 1.94 (s, CH<sub>3</sub>CO), 4.34 (d, J=5.7 Hz, CH<sub>2</sub>), 5.77 (d, J=8.1 Hz, CH), 7.24–7.32 (m, C<sub>3</sub>H, C<sub>5</sub>H, C<sub>6</sub>H, Ph), 7.54 (d, J=7.0 Hz, C<sub>4</sub>H or C<sub>7</sub>H), 7.62 (d, J=7.0 Hz, C<sub>4</sub>H or C<sub>7</sub>H), 8.74 (d, J=8.1 Hz, NH), 8.86 (t, J=5.7 Hz, NH).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>): 22.27 (CH<sub>3</sub>CO), 42.30 (CH<sub>2</sub>), 51.22 (CH), 104.34 (C<sub>3</sub>), 110.90 (C<sub>7</sub>), 121.05 (C<sub>4</sub>), 122.90 (C<sub>5</sub>), 124.28 (C<sub>6</sub>), 126.73 (C<sub>3</sub>), 127.01 (2C<sub>2</sub> or 2C<sub>3</sub>), 127.69 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.14 (C<sub>4</sub>), 138.87 (C<sub>1</sub>), 154.10 (C<sub>7</sub>), 154.30 (C<sub>2</sub>), 167.40 (CH<sub>3</sub>CO), 169.26 (CONH) ppm.

IR (KBr): 3230, 1625 (br), 1520 (br), 1440, 1090, 1085, 890, 785, 690 cm<sup>–1</sup>.

Mass spectrum, m/e (relative intensity): 322 (5), 279 (1), 264 (1), 234 (1), 215 (5), 189 (45), 146 (100), 130 (11), 118 (7), 91 (87), 65 (16).

High resolution mass spectrum, Calcd for  $C_{19}H_{18}N_2O_3$  322.1317. Found 322.1318.

## EXAMPLE 22

Preparation of (D,L)- $\alpha$ -Acetamido-N-benzyl-2-benzo[b]thiopheneacetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (1.00 g, 4 mmol) was suspended in anhydrous ethyl ether (15 mL) and then boron trifluoride etherate (0.91 g, 6.3 mmol) was rapidly added, and the resulting solution was stirred for 15 min. The benzo[b]thiophene (2.14 g, 16 mmol) was then added and the reaction was stirred at room temperature (3 d). The solution was poured into an ice-cold saturated aqueous solution of  $NaHCO_3$ , and then stirred for 15 min at 0° C. The mixture was extracted with ethyl acetate (2 $\times$ ), and the organic layers were combined, dried ( $Na_2SO_4$ ) and evaporated in vacuo to give an orange oil. The oil was triturated with ethyl ether to yield a crystalline product which was filtered and further purified by flash chromatography (99:1 chloroform/methanol) to give the desired product.

Yield: 0.06 g (4%).

$R_f$  0.32 (99:1 chloroform/methanol).

mp 226°–227° C.

$^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.94 (s,  $CH_3CO$ ), 4.34 (d,  $J$ =5.7 Hz,  $CH_2$ ), 5.86 (d,  $J$ =8.1 Hz,  $CH$ ), 7.20–7.38 (m,  $C_3H$ ,  $C_6H$ ,  $C_7H$ , Ph), 7.77–7.80 (m,  $C_4H$  or  $C_5H$ ), 7.89–7.93 (m,  $C_4H$  or  $C_5H$ ), 8.76 (d,  $J$ =8.1 Hz, NH), 8.97 (t,  $J$ =5.7 Hz, NH).

$^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.34 ( $CH_3CO$ ), 42.38 ( $CH_2$ ), 52.70 (CH), 122.15 ( $C_4$  or  $C_7$ ), 122.32 ( $C_4$  or  $C_7$ ), 123.45 ( $C_3$ ), 124.37 ( $C_5$  or  $C_6$ ), 124.41 ( $C_5$  or  $C_6$ ), 126.89 ( $C_4$ ), 127.27 (2 $C_2$  or 2 $C_3$ ), 128.27 (2 $C_2$  or 2 $C_3$ ), 138.84 ( $C_3$  or  $C_7$ ), 138.95 ( $C_3$  or  $C_7$ ), 142.58 ( $C_1$ ), 168.65 ( $CH_3CO$ ), 169.12 (CONH) ppm. [A distinct signal for the  $C_2$  carbon was not detected and is presumed to coincide with the  $C_1$  carbon at 142.58 ppm].

IR (KBr) 3240, 1610 (br), 1510 (br), 1420, 1360, 1215, 1085, 885, 730, 710, 685  $cm^{-1}$ .

Mass spectrum, m/e (relative intensity) 338 (8), 295 (2), 40 205 (76), 162 (100), 135 (22), 108 (12), 91 (59).

Elemental Analysis: Calculated: 67.43% C; 5.36% H; 8.28% N. Found: 67.21% C; 5.37% H; 8.12% N.

## EXAMPLE 23

Preparation of (D,L)- $\alpha$ -Acetamido-N-benzyl-3-indoleacetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (0.69 g, 2.78 mmol) was suspended in anhydrous ethyl ether (20 mL) and then boron trifluoride etherate (0.63 g, 4.40 mmol) was rapidly added, and the resulting solution was stirred for 15 min. The indole (1.30 g, 11.00 mmol) was then added and the reaction was stirred at room temperature (22 h). Petroleum ether (35°–60° C.) was added to the reaction, and the resulting semisolid material filtered, and washed with petroleum ether (35°–60° C.). Purification of the reaction mixture was accomplished by flash chromatography (98:2 chloroform/methanol) to produce the title compound as a white solid.

Yield: 0.25 g (18%).

$R_f$  0.14 (95:5 chloroform/methanol)

mp 213°–214° C.

$^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s,  $CH_3CO$ ), 4.36 (d,  $J$ =6.0 Hz,  $CH_2$ ), 5.72 (d,  $J$ =7.2 Hz,  $CH$ ), 6.90–7.37 (m, Ph,  $C_2H$ ), 7.02 (dd,  $J$ =7.5 Hz,  $J$ =7.5 Hz,  $C_5H$  or  $C_6H$ ), 7.12 (dd,  $J$ =7.5 Hz,  $J$ =7.5 Hz,  $C_5H$  or  $C_6H$ ), 7.39 (d,  $J$ =7.5 Hz,  $C_4H$  or

$C_7H$ ), 7.65 (d,  $J$ =7.5 Hz,  $C_4H$  or  $C_7H$ ), 7.86 (d,  $J$ =7.2 Hz, NHCH), 8.13 (t,  $J$ =6.0 Hz, NHCH<sub>2</sub>), 10.30–10.80 (br s, NH).

$^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.32 ( $CH_3CO$ ), 42.23 ( $CH_2$ ), 49.98 (CH), 111.51 ( $C_7$ ), 112.08 ( $C_3$ ), 118.76 ( $C_4$  or  $C_6$ ), 119.24 ( $C_4$  or  $C_6$ ), 121.37 ( $C_5$ ), 123.94 ( $C_2$ ), 126.58 ( $C_3$ ), 126.71 ( $C_4$ ), 127.33 (2 $C_2$  or 2 $C_3$ ), 128.18 (2 $C_2$  or 2 $C_3$ ), 136.28 ( $C_7$ ), 139.44 ( $C_1$ ), 169.13 ( $CH_3CO$ ), 170.81 (CONH) ppm.

IR (KBr) 3260, 1610 (br), 1515 (br), 1450, 1420, 1370, 1350, 1235, 1095, 895, 735, 715, 695, 600  $cm^{-1}$ .

Mass spectrum, m/e (relative intensity) 321 (5), 278 (1), 264 (1), 233 (1), 214 (6), 187 (85), 171 (3), 145 (100), 118 (18), 91 (39).

Elemental Analysis: Calculated: 71.01% C; 5.96% H; 13.06% N. Found: 70.87% C; 6.15% H; 12.78% N.

## EXAMPLE 24

Preparation of (D,L)- $\alpha$ -Acetamido-N-benzyl-2-(5-methylpyrrole)acetamide.

N-Acetyl-D,L-ethoxyglycine-N-benzylamide (2.00 g, 8 mmol) was suspended in anhydrous ethyl ether (175 mL), and then boron trifluoride etherate (1.38 g, 9.7 mmol) was added and the resulting solution stirred (15 min). The 2-methylpyrrole (0.85 g, 10 mmol) was then added and the reaction mixture was stirred under  $N_2$  (6 d), during which time the color of the reaction mixture turned reddish brown and a dark-brown deposit formed at the bottom of the flask. The clear solution was decanted and treated with an aqueous saturated  $NaHCO_3$  solution containing ice (100 mL) for 30 min. The aqueous reaction mixture was extracted with ethyl acetate (3 $\times$ 30 mL). The combined extracts were dried ( $Na_2SO_4$ ) and the solvent removed in vacuo. The brown oily residue was purified by flash column chromatography using 98:2 chloroform/methanol as the eluent to yield the desired compound. The product was recrystallized from ethyl acetate/hexane to give a light yellow amorphous solid.

Yield 0.20 g (94%).

$R_f$  0.44 (95:5, chloroform/methanol).

mp 167°–168° C.

$^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.87 (s,  $CH_3$ ), 2.13 (s,  $COCH_3$ ), 4.27 (br s,  $CH_2$ ), 5.33 (d,  $J$ =7.4 Hz,  $CH$ ), 5.60 (s,  $C_4H$ ), 5.77 (s,  $C_3H$ ), 7.19–7.30 (m, 5 PhH), 8.22 (d,  $J$ =7.4 Hz, NH), 8.45 (t,  $J$ =5.5 Hz, NH), 10.38 (s, NH).

$^{13}C$  NMR (DMSO-d<sub>6</sub>) 12.74 ( $CH_3$ ), 22.49 ( $COCH_3$ ), 42.11 ( $CH_2$ ), 51.21 (CH), 105.09 ( $C_4$ ), 106.07 ( $C_3$ ), 126.16 ( $C_5$ ), 126.64 ( $C_4$ ), 126.85 ( $C_2$ ), 127.09 (2 $C_2$  or 2 $C_3$ ), 128.17 (2 $C_2$  or 2 $C_3$ ), 139.33 ( $C_1$ ), 168.88 ( $COCH_3$ ), 169.79 (CONH) ppm.

IR (KBr) 3250, 1630, 1520, 1420, 1360, 1300, 1260, 1230, 1160, 1110, 1020  $cm^{-1}$ .

Mass spectrum, m/e (relative intensity) 285 (M<sup>+</sup>, 10), 178 (20), 152 (24), 151 (100), 110 (12), 109 (93), 108 (22), 107 (25), 94 (16), 91 (43).

Elemental Analysis: Calculated: 67.35% C; 6.71% H; 14.73% N. Found: 67.57% C; 6.90% H; 14.52% N.

Synthesis of Unsubstituted and Substituted- $\alpha$ -Acetamido-N-benzyl-2-furanacetamides.

General Procedure.

4-Methylmorpholine (1 equiv) was added to a solution of  $\alpha$ -acetamido-2-furanacetic acid (1 equiv) in dry tetrahydrofuran (75 mL/10 mmol) at -10° to -15° C. under  $N_2$ . After stirring (2 min), isobutyl chloroformate (1 equiv) was added leading to the precipitation of a white solid. The reaction was

allowed to proceed for 2 additional minutes and then a solution of the substituted benzylamine (1 equiv) in tetrahydrofuran (10 mL/10 mmol) was added over 5 min at -10° to -15° C. The reaction mixture was allowed to stir at room temperature for 5 min and then the 4-methylmorpholine hydrochloride salt filtered. The organic layer was concentrated in vacuo, and the residue was triturated with ethyl acetate, and the remaining white solid filtered. Concentration of the ethyl acetate layer led to additional amounts of the white solid. The desired product was purified by either recrystallization, or flash chromatography of the combined solid material. Examples 25-32 were prepared according to this procedure.

#### EXAMPLE 25

(D,L)- $\alpha$ -Acetamido-N-benzyl-2-furanacetamide.

Using benzyl amine (0.27 g, 2.56 mmol) and racemic  $\alpha$ -acetamido-2-furanacetic acid (0.47 g, 2.56 mmol) gave the desired compound. The product was recrystallized from ethyl acetate to give a white solid.

Yield: 0.46 g (65%).

$R_f$  0.30 (98:2 chloroform/methanol).

mp 177°-178° C.

$^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, CH<sub>3</sub>), 4.31 (d, J=6.0 Hz, CH<sub>2</sub>), 5.58 (d, J=8.1 Hz, CH), 6.27-6.33 (m, C<sub>3</sub>H), 6.40-6.44 (m, C<sub>4</sub>H), 7.20-7.36 (m, 5 PhH), 7.60-7.64 (m, C<sub>5</sub>H), 8.57 (d, J=8.1 Hz, NH), 8.73 (t, J=6.0 Hz, NH).

#### EXAMPLE 26

(D,L)- $\alpha$ -Acetamido-N-(2-fluorobenzyl)-2-furanacetamide.

Using 2-fluorobenzylamine (1.13 g, 9.0 mmol) and racemic  $\alpha$ -acetamido-2-furanacetic acid (1.50 g, 8.2 mmol) gave the desired product.

Yield: 120 g (50%).

$R_f$  0.36 (94:4 chloroform/methanol).

mp 193°-195° C. (recrystallized from EtOAc).

$^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, COCH<sub>3</sub>), 4.33 (d, J=5.5 Hz, CH<sub>2</sub>), 5.58 (d, J=80 Hz, CH), 6.28 (s, C<sub>4</sub>H), 6.29 (s, C<sub>3</sub>H), 7.62 (s, C<sub>5</sub>H), 7.13-7.35 (m, 4 ArH), 8.61 (d, J=80 Hz, NH), 8.76 (t, J=5.5 Hz, NH).

$^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.35 (COCH<sub>3</sub>), 36.12 (d, J<sub>CF</sub>=6.6 Hz, CH<sub>2</sub>), 50.88 (CH), 107.64 (C<sub>4</sub>), 110.43 (C<sub>3</sub>), 115.04 (d, J<sub>CF</sub>=21.4 Hz, C<sub>5</sub>), 124.29 (d, J<sub>CF</sub>=4.2 Hz, C<sub>5</sub>), 125.64 (d, J<sub>CF</sub>=15.0 Hz, C<sub>1</sub>), 128.94 (d, J<sub>CF</sub>=9.0 Hz, C<sub>4</sub> or C<sub>6</sub>), 129.27 (d, J<sub>CF</sub>=5.5 Hz, C<sub>4</sub> or C<sub>3</sub>), 142.66 (C<sub>5</sub>), 151.07 (C<sub>2</sub>), 159.99 (d, J<sub>CF</sub>=244.4 Hz, C<sub>2</sub>), 168.17 (COCH<sub>3</sub>), 169.24 (CONH) ppm.

IR (KBr) 3270, 1630, 1520, 1440, 1360, 1220, 1180, 1140, 1100, 1000, 740 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity) 291 (M<sup>+</sup>+1, 3), 274 (2), 247(3), 165 (4), 145 (10), 139 (98), 138 (46), 126 (7), 110 (10), 109 (65), 97 (93), 96 (100).

Elemental Analysis: Calculated: 62.02% C; 5.21% H; 9.65% N. Found: 62.20% C; 5.19% H; 9.69% N.

#### EXAMPLE 27

(D,L)- $\alpha$ -Acetamido-N-(3-fluorobenzyl)-2-furanacetamide.

Making use of 3-fluorobenzylamine (1.13 g, 9.0 mmol) and racemic  $\alpha$ -acetamido-2-furanacetic acid (1.50 g, 8.2 mmol) gave the desired product.

Yield 1.90 g (80%).

$R_f$  0.30 (96:4 chloroform/methanol).

mp 163°-165° C. (recrystallized from ethyl acetate).

$^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, COCH<sub>3</sub>), 4.31 (d, J=5.5 Hz, CH<sub>2</sub>), 5.55 (d, J=7.8 Hz, CH), 6.31 (s, C<sub>4</sub>H), 6.42 (s, C<sub>3</sub>H), 6.98-7.37 (m, 4 ArH), 7.62 (s, C<sub>5</sub>H), 8.61 (d, J=7.8 Hz, NH), 8.70 (t, J=5.5 Hz, NH).

$^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.35 (COCH<sub>3</sub>), 41.71 (CH<sub>2</sub>), 51.01 (CH), 107.73 (C<sub>4</sub>), 110.59 (C<sub>3</sub>), 113.50 (d, J<sub>CF</sub>=21.6 Hz, C<sub>2</sub> or C<sub>4</sub>), 113.60 (d, J<sub>CF</sub>=22.3 Hz, C<sub>2</sub> or C<sub>4</sub>), 122.95 (br, C<sub>6</sub>), 130.18 (d, J<sub>CF</sub>=8.6 Hz, C<sub>5</sub>), 142.21 (d, J<sub>CF</sub>=7.5 Hz, C<sub>1</sub>), 142.66 (C<sub>5</sub>), 151.03 (C<sub>2</sub>), 162.28 (d, J<sub>CF</sub>=243.3 Hz, C<sub>3</sub>), 168.23 (COCH<sub>3</sub>), 169.31 (CONH) ppm.

IR (KBr) 3230, 1630, 1540, 1440, 1360, 1220, 1140, 1000, 730 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity) 290 (M<sup>+</sup>, 71), 231 (7), 165 (18), 140 (23), 130 (100), 126 (16), 109 (6), 97 (118), 96 (100), 96 (30).

Elemental analysis: Calculated: 62.02% C; 5.21% H, 9.65% N. Found: 61.97% C; 5.35% H; 9.53% N.

#### EXAMPLE 28

(D,L)- $\alpha$ -Acetamido-N-(4-fluorobenzyl)-2-furanacetamide.

Using racemic  $\alpha$ -acetamido-2-furanacetic acid (1.50 g, 8.2 mmol) and 4-fluorobenzylamine (1.13 g, 9.0 mmol) gave the desired product.

Yield 2.10 g (88%).

$R_f$  0.30 (96:4 chloroform/methanol).

mp 188°-190° C. (recrystallized from ethyl acetate).

$^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.88 (s, COCH<sub>3</sub>), 4.27 (d, J=5.5 Hz, CH<sub>2</sub>), 5.55 (d, J=8.0 Hz, CH), 6.27 (s, 1H), 6.41 (s, 1H), 7.09-7.15 (m, 2ArH), 7.12-7.27 (m, 2 ArH), 7.61 (s, 1H), 8.58 (d, J=8.0 Hz, NH), 8.75 (t, J=5.5 Hz, NH).

$^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.28 (COCH<sub>3</sub>), 41.51 (CH<sub>2</sub>), 50.87 (CH), 107.52 (C<sub>4</sub>), 110.46 (C<sub>3</sub>), 114.90 (d, J<sub>CF</sub>=21.1 Hz, C<sub>5</sub>), 129.48 (d, J<sub>CF</sub>=8.3 Hz, C<sub>2</sub>), 135.23 (d, J<sub>CF</sub>=3.2 Hz, C<sub>1</sub>), 142.53 (C<sub>5</sub>), 151.08 (C<sub>2</sub>), 161.12 (d, J<sub>CF</sub>=242.2 Hz, C<sub>4</sub>), 167.95 (COCH<sub>3</sub>), 169.13 (CONH) ppm.

IR (KBr) 3230, 1620, 1500, 1360, 1320, 1260, 1210, 1140, 1000, 820, 780, 730 cm<sup>-1</sup>.

Mass spectrum, m/e (relative intensity) 291 (M<sup>+</sup>+1, 4), 165 (4), 140 (9), 139 (92), 138 (52), 124 (6), 109 (71), 97 (60), 96 (100).

Elemental Analysis: Calculated: 62.02% C; 5.21% H; 9.65% N. Found: 61.76% C; 5.41% H; 9.43% N.

#### EXAMPLE 29

(D,L)- $\alpha$ -Acetamido-N-(2,5-difluorobenzyl)-2-furanacetamide.

Using 2,5-difluorobenzylamine (1.30 g, 9.0 mmol) and racemic  $\alpha$ -acetamido-2-furanacetic acid (1.50 g, 8.2 mmol) gave the desired product.

Yield 1.60 g (64%).

$R_f$  0.38 (96:4 chloroform/methanol).

mp 177°-178° C. (recrystallized from ethyl acetate).

$^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, COCH<sub>3</sub>), 4.31 (d, J=5.5 Hz, CH<sub>2</sub>), 5.55 (d, J=7.7 Hz, CH), 6.32 (s, C<sub>4</sub>H), 6.43 (s, C<sub>3</sub>H), 7.22-7.25 (m, 3 ArH), 7.62 (s, C<sub>5</sub>H), 8.62 Hz, NH), 8.78 (t, J=5.5 Hz, NH).

$^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.30 (COCH<sub>3</sub>), 35.98 (d, J<sub>CF</sub>=5.8 Hz, CH<sub>2</sub>), 51.02 (CH), 107.81 (C<sub>4</sub>), 110.58 (C<sub>3</sub>), 115.06 (dd, J<sub>CF</sub>=19.5, 25.6 Hz, C<sub>5</sub> or C<sub>6</sub>), 115.16 (dd, J<sub>CF</sub>=15.6, 24.7 Hz, C<sub>3</sub> or C<sub>6</sub>), 116.52 (dd, J<sub>CF</sub>=10.1, 23.9 Hz, C<sub>4</sub>), 127.98 (dd, J<sub>CF</sub>=9.2, 17.7 Hz, C<sub>1</sub>), 142.69 (C<sub>5</sub>), 150.78 (C<sub>2</sub>), 155.89 (d, J<sub>CF</sub>=239.0 Hz, C<sub>2</sub> or C<sub>5</sub>), 158.18 (d, J<sub>CF</sub>=238.8 Hz, C<sub>2</sub> or C<sub>5</sub>), 168.38 (COCH<sub>3</sub>), 169.35 (CONH) ppm.

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IR (KBr) 3230, 1620, 1520, 1480, 1360, 1260, 1230, 1180, 1140, 1000, 860, 810, 730, 710  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity) 309 ( $M^++1$ , 1), 266 (1), 222 (1), 165 (5), 140 (5), 139 (61), 138 (36), 127 (37), 97 (44), 96 (100).

Elemental Analysis: Calculated: 58.44% C; 4.58% H; 9.09% N. Found: 58.68% C; 4.69% H; 8.87% N.

## EXAMPLE 30

(D,L)- $\alpha$ -Acetamido-N-(2,6-difluorobenzyl)-2-furanacetamide.

Making use of 2,6-difluorobenzylamine (1.30 g, 9.0 mmol) and racemic  $\alpha$ -acetamido-2-furanacetic acid (1.50 g, 8.2 mmol) the desired product was formed.

Yield 1.90 g (73%).

mp 237°–239° C. (recrystallized from ethanol).

$^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.86 (COCH<sub>3</sub>), 4.33 (d,  $J=4.5$  Hz, CH<sub>2</sub>), 5.53 (d,  $J=8.3$  Hz, CH, 6.17 (s, C<sub>4</sub>H), 6.38 (s, C<sub>3</sub>H), 7.05–7.10 (m, 2 ArH, 7.36–7.41 (m, 1 ArH, 7.60 (s, C<sub>5</sub>H), 8.52 (d,  $J=8.3$  Hz, NH), 8.66 (t,  $J=4.5$  Hz, NH).

$^{13}\text{C}$  NMR (DMSO- $d_6$ )  $\delta$  22.33 (COCH<sub>3</sub>), 30.74 (t,  $J_{CF}=4.4$  Hz, CH<sub>2</sub>), 50.48 (CH), 107.24 (C<sub>4</sub>), 110.40 (C<sub>3</sub>), 111.61 (dd,  $J_{CF}=8.0$ , 25.1 Hz, C<sub>3</sub>, C<sub>5</sub>), 113.67 (t,  $J_{CF}=19.5$  Hz, C<sub>1</sub>), 129.98 (t,  $J_{CF}=10.5$  Hz, C<sub>4</sub>), 142.50 (C<sub>5</sub>), 151.23 (C<sub>2</sub>), 160.93 (d,  $J_{CF}=248.1$ , C<sub>2</sub> or C<sub>6</sub>), 161.10 (d,  $J_{CF}=248.1$  Hz, C<sub>2</sub> or C<sub>6</sub>), 167.59 (COCH<sub>3</sub>), 169.00 (CONH) ppm.

IR (KBr) 3230, 1620, 1530, 1460, 1360, 1320, 1260, 1220, 1160, 1140, 1030, 1000, 820, 780, 750, 740, 710  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity) 309 ( $M^++1$ , 4), 265 (2), 165 (4), 147 (7), 140 (8), 139 (87), 138 (36), 127 (54), 97 (58), 96 (100).

Elemental Analysis: Calculated: 58.44% C; 4.58% H; 9.09% N. Found: 58.62% C; 4.74% H; 8.89% N.

## EXAMPLE 31

(D)- $(-)$  $\alpha$ -Acetamido-N-benzyl-2-furanacetamide

Starting with D- $\alpha$ -acetamido-2-furanacetic acid (2.45 g, 13.38 mmol) and benzylamine (1.43 g, 13.38 mmol), the desired product was obtained.

Yield: 2.54 g (70%) The product was further recrystallized from ethyl acetate to give the title compound

Yield: 2.30 g

mp 196°–197° C.

$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=-78.3^\circ$ . Addition of R- $(-)$ -mandelic acid to a  $\text{CDCl}_3$  solution of the product gave only one signal for the acetamide methyl protons.

Mass spectrum, m/e (relative intensity) 272 ( $M^+$ , 2), 184 (2), 165 (2), 140 (8), 139 (88), 138 (34), 97 (46), 96 (100), 91 (63).

Elemental Analysis: Calculated: 66.16% C; 5.92% H; 10.29% Found: 66.09% C; 6.01% H; 10.38% N.

## EXAMPLE 32

(L)- $(+)$  $\alpha$ -Acetamido-N-benzyl-2-furanacetamide.

Using L- $\alpha$ -acetamido-2-furanacetic acid (2.83 g, 15.46 mmol) and benzylamine (1.65 g, 15.46 mmol) gave 3.80 g of the enriched desired product.  $^1\text{H}$  NMR analysis with R- $(-)$ -mandelic acid showed that it was greater than 80% enriched in the title compound. The pure L-enantiomer was obtained by recrystallization from absolute ethanol.

Yield: 1.60 g.

mp 196°–197° C.

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$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=+79.0^\circ$ .

Mass spectrum, m/e (relative intensity) 273 ( $M^++1$ , 3), 229 (2), 214 (2), 184 (1), 165 (7), 157 (4), 140 (33), 139 (100), 138 (95), 97 (98), 96 (100), 91 (98).

Elemental Analysis: Calculated: 66.16% C; 5.92% H; 10.29% N. Found: 65.89% C; 5.86% H; 10.42% N.

## EXAMPLE 33

10 Resolution of (D,L)- $\alpha$ -Acetamido-2-furanacetic acid Using (R)- $(+)$ - $\alpha$ -Methylbenzylamine and (S)- $(-)$ - $\alpha$ -Methylbenzylamine.

(R)- $(+)$ - $\alpha$ -Methylbenzylamine (13.22 g, 0.11 mol) was added to an absolute ethanol solution (550 mL) of racemic 15  $\alpha$ -acetamido-2-furanacetic acid (20.00 g, 0.11 mol). The resulting solution was cooled in the freezer overnight. The white precipitate (12.00 g) which separated upon cooling was filtered, and the mother liquid evaporated to give a salt which was later used for obtaining L- $\alpha$ -acetamido-2-furanacetic acid. The initial salt was recrystallized (3 $\times$ ) from absolute ethanol to yield 4.00 g of the pure diastereomeric salt.

mp 173°–175° C.

$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=-108^\circ$ .

Elemental Analysis Calculated: 63.14% C; 6.62% H; 9.21% N. Found: 63.19% C; 6.62% H; 9.12% N.

The purified salt was treated with 5% aqueous  $\text{NH}_4\text{OH}$  solution, extracted with ethyl ether (3 $\times$ 50 mL), and then acidified with a 8.5% aqueous solution of  $\text{H}_3\text{PO}_4$  and then extracted with ethyl acetate (3 $\times$ 100 mL) to yield 2.45 g (25%) of D- $\alpha$ -acetamido-2-furanacetic acid.

mp 69°–171° C.

$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=-184.2^\circ$ .

Elemental Analysis Calculated: 52.46% C; 4.95% H; 7.65% N. Found: 52.17% C; 4.89% H; 7.56% N.

The salt obtained after evaporation of the main mother liquor was hydrolysed with 5% aqueous  $\text{NH}_4\text{OH}$  solution to give 10.10 g of the enriched L- $\alpha$ -acetamido-2-furanacetic acid  $[[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=+47.7^\circ]$ . (S)- $(-)$ - $\alpha$ -Methylbenzylamine (6.70 g, 0.055 mol) was added to a solution of enriched L- $\alpha$ -acetamido-2-furanacetic acid (10.10 g, 0.055 mol) in absolute ethanol (275 mL). The white precipitate of the diastereomeric salt (8.10 g) that separated upon cooling the solution in the freezer (1 h) was filtered. The salt was recrystallized from absolute ethanol (3 $\times$ ) to yield 3.00 g of the salt.

mp 172°–174° C.

$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=+106^\circ$ .

Elemental Analysis Calculated: 63.14% C; 6.62% H; 9.21% N. Found: 63.18% C; 6.47% H; 9.00% N.

The salt from the third recrystallization was treated with a 5% aqueous  $\text{NH}_4\text{OH}$  solution and extracted with ethyl ether (3 $\times$ 50 mL), and then acidified with a 8.5% aqueous solution of  $\text{H}_3\text{PO}_4$  and then extracted with ethyl acetate (3 $\times$ 100 mL) to give 1.63 g (32%) of L- $\alpha$ -acetamido-2-furanacetic acid.

mp 169°–171° C.

$[\alpha]^{26}\text{D}_{[\text{c}=1, \text{MeOH}]}=+182^\circ$ .

## EXAMPLE 34

65 Enzymatic Separation of D- $(-)$  $\alpha$ -acetamido-2-furanacetic acid (R-19) from DL  $(\pm)$  $\alpha$ -acetamido-2-furanacetic acid.

DL  $(\pm)$  $\alpha$ -acetamido-2-furanacetic acid (2.00 g, 10.9 mmol) was suspended in deionized  $\text{H}_2\text{O}$  (600 mL). An

aqueous solution of LiOH (1N) was added to this suspension dropwise until all of the acid had dissolved and the pH was 7.2. Acylase 1, Grade II (20 mg, activity=900 units/mg, Sigma Chemical Company, Cat. No. A 8376) was then added to the above solution and the mixture stirred at 34°–37° C. (41 h). The suspension was then cooled to room temperature and acidified to pH 1.5 with aqueous 1N HCl. The suspended material was filtered, and the filtrate was saturated with solid NaCl, and then extracted with ethyl acetate (3×250 mL). The combined ethyl acetate extracts was dried (Na<sub>2</sub>SO<sub>4</sub>). The solvent was removed in vacuo and the residue was triturated with ethyl acetate (10 mL). The white solid (0.75 g) that remained was filtered and was pure D(–)α-acetamido-2-furanacetic acid; mp 168°–169° C., mixed mp with an authentic sample 168°–169° C.; [α]<sub>D</sub><sup>26</sup> [c=1, MeOH]=–184.3°.

### EXAMPLE 35

#### Preparation of D,L-α-Acetamido-2-furanacetic Acid.

An ethereal solution of ZnCl<sub>2</sub> (1N, 28 mL, 0.028 mol) was added to a stirred solution of ethyl acetamido-2-bromoacetate (4.40 g, 0.019 mol) and furan (11.23 g, 0.165 mol) in dry tetrahydrofuran (100 mL), and allowed to stir at room temperature (5 h). The mixture was then treated with H<sub>2</sub>O (50 mL), the organic phase separated, and the aqueous layer extracted with CH<sub>2</sub>Cl<sub>2</sub> (2×100 mL). The organic layers were combined, dried (Na<sub>2</sub>SO<sub>4</sub>) and the volatile materials were removed by distillation in vacuo to give approximately 4.00 g (97%) of light-brown semi-solid material. TLC analysis showed a major spot at *R*<sub>f</sub> 0.30 (99:1 chloroform/methanol). The desired compound, D,L-ethyl α-acetamido-2-furanacetate, was purified by flash column chromatography on silica gel using 99:1 chloroform/methanol as the eluent to give 3.60 g (87%) of a beige solid.

mp 68°–70° C.

D,L-Ethyl α-acetamido-2-furanacetate (4.00 g, 19 mmol) was dissolved in 90:10 ethanol/water (150 mL) and then KOH (2.00 g, 35 mmol) was added and the resulting solution stirred at room temperature (48 h). The reaction was concentrated in vacuo and the residue diluted with H<sub>2</sub>O and then washed with ethyl ether (3×50 mL). The aqueous layer was then made acidic with a 8.5% aqueous solution of H<sub>3</sub>PO<sub>4</sub> and extracted with ethyl acetate (3×150 mL). The organic layers were combined, dried (Na<sub>2</sub>SO<sub>4</sub>), evaporated to dryness in vacuo to give the desired compound.

Yield: 2.65 g (76%).

*R*<sub>f</sub> 0.37 (8:1:1 isopropanol/NH<sub>4</sub>OH/H<sub>2</sub>O).

mp 172°–174° C.

### EXAMPLE 36

#### Synthesis of (D,L)-α-Acetamido-4-pentenoic Acid-N-benzylamide.

4-Methylmorpholine (0.55 g, 5.40 mmol) was added to a stirred solution of 2-acetamido-4-pentenoic acid (0.81 g, 5.18 mmol) in dry tetrahydrofuran (60 mL) at –10° to –15° C. under N<sub>2</sub>. After stirring (2 min), isobutyl chloroformate (0.75 g, 5.70 mmol) was added leading to the precipitation of a white solid. The reaction was allowed to proceed for 2 additional minutes and then a solution of benzylamine (0.61 g, 5.70 mmol) in tetrahydrofuran (10 mL) was added slowly at –10° to –15° C. After stirring (5 min) at room temperature, the insoluble salt was removed by filtration. The filtrate was evaporated to dryness and the residue was triturated with ethyl acetate, and the remaining white solid was filtered to yield the desired product.

Yield 0.81 g (64%).

*R*<sub>f</sub> 0.36 (4% methanol/chloroform).

mp 118°–120° C. (recrystallized from ethyl acetate/cyclohexane).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.83 (s, COCH<sub>3</sub>), 2.22–2.49 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 4.26 (d, *J*=5.3 Hz, CH<sub>2</sub>Ph), 4.25–4.33 (m, CH), 4.99–5.09 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 7.21–7.29 (m, 5 PhH), 8.05 (d, *J*=7.6 Hz, NH), 8.46 (br s, NH).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.41 (COCH<sub>3</sub>), 36.24 (CH<sub>2</sub>CH=CH<sub>2</sub>), 41.91 (CH<sub>2</sub>Ph), 52.20 (CH), 117.15 (CH<sub>2</sub>CH=CH<sub>2</sub>), 126.54 (C<sub>4</sub>), 126.99 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.04 (2C<sub>2</sub> or 2C<sub>3</sub>), 134.25 (CH<sub>2</sub>CH=CH<sub>2</sub>), 139.22 (C<sub>1</sub>), 169.02 (COCH<sub>3</sub>), 170.96 (CONH) ppm.

Mass spectrum, m/e (relative intensity) 246 (M<sup>+</sup>, 4), 205 (4), 163 (15), 140 (8), 106 (33), 91 (77), 70 (100).

Elemental Analysis: Calculated: 68.27% C; 7.37% H; 11.37% N. Found: 68.55% C; 7.31% H; 11.48% N.

Mass spectrum m/e (relative intensity) 292 (M<sup>+</sup>+1, 1), 233 (8), 158 (19), 157 (100), 116 (26), 115 (100), 106 (29), 91 (72).

Elemental Analysis: Calculated: 61.84% C; 7.26% H; 14.42% N. Found: 61.67% C; 7.10% H; 14.14% N.

### EXAMPLE 37

#### Synthesis of (D,L)-2-Acetamido-N-benzyl-2-(1-morpholine)acetamide.

A mixture of ethyl 2-acetamido-2-(1-morpholine)acetate (0.59 g, 2.56 mmol), benzylamine (0.28 g, 2.82 mmol) and sodium cyanide (0.01 g, 0.26 mmol) in methanol (5 mL) was stirred at 50°–55° C. for 18 hr. The solvent was removed in vacuo and the residue triturated with ethyl acetate (5 mL). The white solid (0.35 g) that remained was collected by

filtration and identified as the desired compound. The filtrate was concentrated and the residue purified by flash column chromatography (2% methanol/chloroform) on SiO<sub>2</sub>. The initial fractions gave a trace amount (0.09 g) of (D,L)-2-acetamido-N-benzyl-2-(N-benzylamine)acetamide. Continued elution gave additional amounts (0.20 g) of the title compound.

(D,L)-2-Acetamido-N-benzyl-2-(N-benzylamine)acetamide:

Yield: 0.09 g (11%).

mp 135°–138° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.83 (s, COCH<sub>3</sub>), 3.56 (d, *J*=13.6 Hz, NHCH), 3.66 (d, *J*=13.6 Hz, NHCH), 4.23 (d, *J*=5.4 Hz, CH<sub>2</sub>), 4.89 (d, *J*=8.0 Hz, CH), 7.05–7.38 (m, 10 PhH), 8.20 (d, *J*=8.0 Hz, NH), 8.51 (t, *J*=5.4 Hz, NH).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.63 (COCH<sub>3</sub>), 42.11 (CH<sub>2</sub>), 48.57 (NHCH<sub>2</sub>), 64.41 (CH), 126.65 (C<sub>4</sub>), 126.70 (C<sub>4</sub>), 127.13, 128.00, 128.13, 128.22, 139.24 (C<sub>1</sub> or C<sub>1</sub>), 140.12 (C<sub>1</sub> or C<sub>1</sub>), 169.61 (COCH<sub>3</sub>), 169.90 (CONH) ppm.

(D,L)-2-Acetamido-N-2-benzyl-2-(1-morpholine)acetamide.

Yield: 0.48 g (64%).

*R*<sub>f</sub> 0.35 (4% methanol/chloroform).

mp 171°–172° (recrystallized from ethyl acetate).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.86 (s, COCH<sub>3</sub>), 2.30–2.40 (m, CH<sub>2</sub>NCH<sub>2</sub>), 3.51 (br s, CH<sub>2</sub>OCH<sub>2</sub>), 4.18–4.33 (m, CH<sub>2</sub>), 5.07 (d, *J*=8.9 Hz, CH), 7.18–7.25 (m, 5 PhH), 8.23 (d, *J*=8.9 Hz, NH), 8.58 (br s, NH).

<sup>13</sup>C (DMSO-d<sub>6</sub>) 22.39 (COCH<sub>3</sub>), 42.20 (CH<sub>2</sub>), 48.43 (CH<sub>2</sub>NCH<sub>2</sub>), 66.03 (CH), 69.24 (CH<sub>2</sub>OCH<sub>2</sub>), 126.76 (C<sub>4</sub>), 127.13 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.23 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.42 (C<sub>1</sub>).

## EXAMPLE 38

Synthesis of (D,L)-Ethyl 2-acetamido-2-(ethylamino)acetate.

A cold (-78° C.) solution of ethyl 2-acetamido-2-bromoacetate (2.10 g, 9.38 mmol) in dry tetrahydrofuran (80 mL) was added slowly into a cooled (-78° C.) tetrahydrofuran (20 mL) solution of methylamine (1.40 g, 31.04 mmol) over a period of 20 min. The reaction was stirred at -78° C. (1 h), and then at room temperature (1 h). The precipitated salt was filtered and the filtrate concentrated. The residue was purified by flash column chromatography on SiO<sub>2</sub> using 3% methanol/chloroform as the eluent to yield the desired compound as a light yellow oil.

Yield: 0.90 (51%).

R<sub>f</sub> 0.36 (4% methanol/chloroform).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) 0.93 (t, J=6.7 Hz, NHCH<sub>2</sub>CH<sub>3</sub>), 1.12 (t, J=6.8 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 1.87 (s, COCH<sub>3</sub>), 2.48 (q, J=6.7 Hz, NHCH<sub>2</sub>CH<sub>3</sub>), 4.05 (q, J=6.8 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 5.05 (d, J=7.1 Hz, CH), 7.09 (d, J=7.1 Hz, NH).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 13.64 (NHCH<sub>2</sub>CH<sub>3</sub>), 14.55 (OCH<sub>2</sub>CH<sub>3</sub>), 22.53 (COCH<sub>3</sub>), 39.06 (NHCH<sub>2</sub>CH<sub>3</sub>), 61.38 (CH), 64.14 (OCH<sub>2</sub>CH<sub>3</sub>), 170.09 (COCH<sub>3</sub>), 170.20 (COOCH<sub>2</sub>CH<sub>3</sub>) ppm.

## EXAMPLE 39

Using the procedures described herein, the following examples are also prepared:

(D,L)- $\alpha$ -Acetamido-N-benzyl-3-furanacetamide

(D,L)- $\alpha$ -Acetamido-N-(2-fluorobenzyl)-3-furanacetamide

(D,L)- $\alpha$ -Acetamido-N-(3-fluorobenzyl)-3-furanacetamide

(D,L)- $\alpha$ -Acetamide-N-(4-fluorobenzyl)-3-furanacetamide

$\alpha$ -Acetamide-N-benzyl-2-aminoacetamide

Preparation of  $\alpha$ -Heteroatom Substituted Amino Acids, Synthesis of Ethyl 2-Acetamido-2-substituted Acetates.

General Procedure.

A cooled (-78° C.) solution of ethyl 2-bromo-2-acetamidoacetate (1 equiv) in THF (1 mmol/10 mL) was added slowly to a THF (1 mmol/4 mL) solution of the nitrogen nucleophile (5-10 equiv) at -78° C. The reaction was stirred at this temperature (0.5 h) and then at room temperature (1 h). The insoluble materials were filtered and washed with THF. The filtrate was concentrated in vacuo and the residue was purified by flash chromatography on SiO<sub>2</sub> gel (using the indicated solvent as the eluent) to give the desired product.

Using this procedure the following examples were prepared.

## EXAMPLE 40

Synthesis of Ethyl 2-Acetamido-2-aminoacetate.

Ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.93 mmol) and liquid NH<sub>3</sub> (5-6 equiv) yielded a light brown residue, which on purification by flash column chromatography on SiO<sub>2</sub> gel (5% MeOH/CHCl<sub>3</sub>) gave the desired product as a yellow oil.

Yield: 1.00 g (70%).

R<sub>f</sub> 0.21 (5% MeOH/CHCl<sub>3</sub>).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.31 (t, J=7.1 Hz, 3H), 2.03 (s, 3H), 2.61 (br s, 2H), 4.24 (q, J=7.1 Hz, 2H), 5.21 (d, J=7.1 Hz, 1H), 7.50 (d, J=7.1 Hz, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 13.72, 22.68, 59.70, 61.73, 170.40, 170.68 ppm.

## EXAMPLE 41

Synthesis of Ethyl 2-Acetamido-2-(methylamino)acetate.

Use of ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.93 mmol) and MeNH<sub>2</sub> (2.50 g, 80.6 mmol) gave an oily residue (1.50 g). The residue was purified by flash column chromatography on SiO<sub>2</sub> gel (3% MeOH/CHCl<sub>3</sub>) to yield the desired product as an oil.

Yield: 1.00 g (65%).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.32 (t, J=7.1 Hz, 3H), 2.07 (s, 3H), 2.36 (s, 3H), 4.26 (q, J=7.1 Hz, 2H), 5.20 (d, J=7.4 Hz, 1H), 6.60 (br s, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 14.02, 23.06, 30.84, 62.04, 65.72, 170.09, 170.40 ppm.

## EXAMPLE 42

Synthesis of Ethyl 2-Acetamido-2-(N,N-dimethylamino)acetate.

Ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.93 mmol) and Me<sub>2</sub>NH (5-6 equiv) gave the desired product as a yellow oil.

Yield: 1.50 g (89%).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.25 (t, J=7.1 Hz, 3H), 2.02 (s, 3H), 2.33 (s, 6H), 4.10-4.25 (m, 2H), 5.24 (d, J=8.3 Hz, 1H), 6.59 (d, J=8.3 Hz, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 14.05, 23.00, 40.28 (2 C), 61.84, 69.24, 169.38, 170.57 ppm.

## EXAMPLE 43

Synthesis of Ethyl 2-Acetamido-2-(4-morpholine)acetate.

Using morpholine (1.71 g, 19.64 mmol) and ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.93 mmol) gave an oily residue, which was purified by flash column chromatography on SiO<sub>2</sub> gel (2% MeOH/CHCl<sub>3</sub>) to give the desired product as a thick oil.

Yield: 1.90 g (93%).

R<sub>f</sub> 0.29 (3% MeOH/CHCl<sub>3</sub>).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.32 (t, J=6.8 Hz, 3H), 2.07 (s, 3H), 2.43-2.72 (m, 4H), 3.58-3.78 (m 4H), 4.26 (q, J=6.8 Hz, 2H), 5.27 (d, J=7.9 Hz, 1H), 6.39 (d, J=7.9 Hz, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 14.21, 23.25, 48.47 (2 C), 62.06, 66.71 (2 C), 69.22, 169.00, 170.46 ppm.

## EXAMPLE 44

Synthesis of Ethyl 2-Acetamido-2-(N-anilino)acetate.

Use of aniline (1.83 g, 19.6 mmol) and ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.93 mmol) provided a brown residue which was purified by flash column chromatography on SiO<sub>2</sub> gel (CHCl<sub>3</sub>-2% MeOH/CHCl<sub>3</sub> gradient) to yield the desired product.

Yield: 1.80 g (85%).

R<sub>f</sub> 0.52 (4% MeOH/CHCl<sub>3</sub>).

mp 87°-89° C. (recrystallized from ethyl acetate/petroleum ether).

<sup>1</sup>H NMR (CDCl<sub>3</sub>) δ 1.29 (t, J=7.1 Hz, 3H), 1.84 (s, 3H), 4.27 (q, J=7.1 Hz, 2H), 5.89 (d, J=8.2 Hz, 1H), 6.43 (d, J=8.2 Hz, 1H), 6.68-6.71 (m, 2H), 6.80-6.83 (m, 1H), 7.17-7.22 (m, 2H). The remaining amino proton was not detected.

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 13.96, 22.98, 60.19, 62.41, 113.87 (2 C), 119.29, 129.37 (2 C), 144.09, 169.77, 170.14 ppm.

IR (KBr) 3340, 1720, 1635, 1590, 1490, 730, 710 cm<sup>-1</sup>. Mass spectrum (FD) 237 (M<sup>30</sup>+1).

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Elemental analysis Calculated for  $C_{12}H_{16}N_2O_3$  61.00% C; 6.83% H; 11.86% N. Found 60.88% C; 6.56% H; 12.00% N.

## EXAMPLE 45

Synthesis of Ethyl 2-Acetamido-2-(N-(3-pyrazolylamino))acetate.

Using ethyl 2-bromo-2-acetamidoacetate (2.00 g, 8.92 mmol) and 3-aminopyrazole (1.85 g, 22.32 mmol) and purification of the reaction product by chromatography on  $SiO_2$  gel (2% MeOH/CHCl<sub>3</sub>) gave the desired product as a yellow oil.

Yield: 1.80 g (89%).

$R_f$  0.35 (8% MeOH/CHCl<sub>3</sub>).

<sup>1</sup>H NMR (CDCl<sub>3</sub>)  $\delta$  1.21 (t, J=7.1 Hz, 3H), 1.89 (s, 3H), 4.20 (q, J=7.1 Hz, 2H), 5.64 (d, J=1.8 Hz, 1H), 5.71 (br s, 1H), 5.73 (d, J=7.1 Hz, 1H), 7.29 (d, J=1.8 Hz, 1H), 7.98 (d, J=7.1 Hz, 1H). The remaining amino proton was not detected.

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 13.73, 22.49, 61.41, 62.02, 91.79, 130.53, 153.02, 169.96, 170.93 ppm.

## EXAMPLE 46

Synthesis of Ethyl 2-Acetamido-2-hydroxyaminoacetate.

Using ethyl 2-bromo-2-acetamidoacetate (2.10 g, 9.37 mmol) and anhydrous NH<sub>2</sub>OH (0.93 g, 28.00 mmol) gave an oily residue. The residue was purified by flash column chromatography on  $SiO_2$  gel (5% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was recrystallized from EtOH to give a white flaky solid.

Yield: 1.00 g (61%).

$R_f$  0.24 (5% MeOH/CHCl<sub>3</sub>).

mp 119°–121° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.19 (t, J=6.9 Hz, 3H), 1.87 (s, 3H), 4.10 (q, J=6.9 Hz, 2H), 5.09 (dd, J=4.0, 8.0 Hz, 1H), 6.06 (br s, 1H), 7.63 (s, 1H), 8.50 (d, J=8.0 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 14.05, 22.46, 60.82, 67.37, 169.19, 169.48 ppm.

IR (KBr) 3300, 1750, 1660, 1540, 1390, 610 cm<sup>–1</sup>.

Mass spectrum (FD) 177 (M<sup>+</sup>+1).

Elemental analysis Calculated for  $C_6H_{12}N_2O_4$  40.91% C; 6.87% H; 15.90% N. Found 40.79% C; 6.87% H; 15.90% N.

## EXAMPLE 47

Synthesis of Ethyl 2-Acetamido-2-(N-(N-methylhydroxyamino))acetate.

MeNHOH (17.39 mmol) (prepared from MeNHOH.HCl (2.00 g, 23.95 mmol) and NaOMe (0.94 g, 17.39 mmol)), and ethyl 2-bromo-2-acetamidoacetate (1.00 g, 4.46 mmol) gave an oily residue. The residue was triturated with EtOAc (5 mL) and the solid that remained was filtered and recrystallized from EtOH to give the desired product as a white solid.

Yield: 0.70 g (82%).

$R_f$  0.34 (5% MeOH/CHCl<sub>3</sub>).

mp 148°–150° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.17 (t, J=7.0 Hz, 3H), 1.89 (s, 3H), 2.37 (s, 3H), 4.00–4.20 (m, 2H), 5.04 (d, J=9.2 Hz, 1H), 8.17 (s, 1H), 8.43 (d, J=9.2 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 14.04, 22.28, 43.78, 60.79, 71.46, 168.29, 170.23 ppm.

IR (KBr) 3320, 3200 (br), 1760, 1660, 1530, 1470, 720, 640 cm<sup>–1</sup>.

42

Mass spectrum (FD) 192 (M<sup>+</sup>+1).

Elemental analysis Calculated for  $C_7H_{14}N_2O_4$  0.25 H<sub>2</sub>O 43.18% C; 7.51% H; 14.39% N. Found 43.28% C; 7.25% H; 14.64% N.

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## EXAMPLE 48

Synthesis of Ethyl 2-Acetamido-2-(N-(N,O-dimethylhydroxyamino))acetate.

MeNHOH (17.40 mmol) (prepared from MeNHOH.HCl (2.18 g, 22.32 mmol) and NaOMe (0.94 g, 17.40 mmol)) and ethyl 2-bromo-2-acetamidoacetate (1.00 g, 4.46 mmol) gave a residue which was purified by flash column chromatography on  $SiO_2$  gel (1% MeOH/CHCl<sub>3</sub>) to give the desired product as an oil.

Yield: 0.60 g (66%).

$R_f$  0.53 (2% MeOH/CHCl<sub>3</sub>).

<sup>1</sup>H NMR (CDCl<sub>3</sub>)  $\delta$  1.35 (t, J=7.0 Hz, 3H), 2.12 (s, 3H), 2.62 (s, 3H), 3.46 (s, 3H), 4.30 (q, J=7.0 Hz, 2H), 5.36 (d, J=8.9 Hz, 1H), 6.66 (d, J=8.9 Hz, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 14.06, 22.89, 40.30, 60.01, 61.89, 70.16, 168.14, 170.53 ppm.

Synthesis of 2-Acetamido-N-benzyl-2-substituted Acetamides.

25 General Procedure.

A mixture of the ethyl 2-substituted-2-acetamidoacetate (1 equiv), benzylamine (1.2 equiv), and NaCN (0.1 equiv) in MeOH (1 mmol/25 mL) was stirred at 45°–50° C. (18 h). The solvent was removed in vacuo and the residue was purified using either trituration with EtOAc or flash column chromatography on  $SiO_2$  gel with the indicated solvent as the eluent.

Using this procedure the following examples were prepared.

## EXAMPLE 49

Synthesis of 2-Acetamido-N-benzyl-2-aminoacetamide.

40 Ethyl 2-acetamido-2-aminoacetate (1.00 g, 6.25 mmol), benzylamine (0.80 g, 7.5 mmol) and NaCN (0.03 g, 0.61 mmol) gave a residue which solidified on standing (18 h). The reaction mixture was triturated with EtOAc (20 mL). The white solid which remained was filtered and then further purified by recrystallization from EtOAc.

Yield: 1.00 g (72%).

$R_f$  0.21 (5% MeOH/CHCl<sub>3</sub>).

mp 131°–133° C. (dec.).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.83 (s, 3H), 2.35 (br s, 2H), 4.28 (d, J=4.4 Hz, 2H), 4.91 (d, J=7.0 Hz, 1H), 7.20–7.32 (m, 5H), 8.31 (br s, 1H), 8.51 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.6, 42.05, 60.29, 126.67, 127.10 (2 C), 128.18 (2 C), 139.23, 169.24, 170.67 ppm.

IR (KBr) 3300, 1650 (br), 1530 (br), 1450, 740 cm<sup>–1</sup>.

55 Mass spectrum, m/e (relative intensity) 222 (M<sup>+</sup>+100), 221 (M<sup>+</sup>, 29), 133 (8).

Elemental analysis Calculated for  $C_{11}H_{15}N_3O_2$  59.71% C; 6.83% H; 18.99% N. Found 59.86% C; 6.88% H; 18.72% N.

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## EXAMPLE 50

Synthesis of 2-Acetamido-N-benzyl-2-(methylamino)acetamide.

65 Ethyl 2-acetamido-2-(methylamino)acetate (1.50 g, 8.63 mmol), benzylamine (1.11 g, 10.35 mmol) and NaCN (0.04 g, 0.82 mmol) gave a brown residue which was purified by

flash column chromatography on  $\text{SiO}_2$  gel (2% MeOH/CHCl<sub>3</sub>) to yield the desired product.

Yield: 1.00 g (49%).

$R_f$  0.33 (3% MeOH/CHCl<sub>3</sub>).

mp 115°–117° C. (recrystallized from ethyl acetate/petroleum ether).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.87 (s, 3H), 2.18 (s, 3H), 4.20–4.29 (m, 2H), 4.87 (d,  $J$ =7.9 Hz, 1H), 7.24–7.35 (m, 5H), 8.14 (d,  $J$ =7.9 Hz, 1H), 8.55 (br s, 1H). The remaining amino proton was not detected.

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.52, 31.37, 42.04, 65.99, 126.68, 127.12 (2 C), 128.18 (2 C), 139.28, 169.51, 169.83 ppm.

IR (KBr) 3240, 1610 (br), 1500 (br), 1430, 725, 670  $\text{cm}^{-1}$ .

Elemental analysis Calculated for C<sub>12</sub>H<sub>17</sub>N<sub>3</sub>O<sub>2</sub> 61.26% C; 7.28% H; 17.86% N. Found 61.12% C; 7.01% H; 17.71% N.

#### EXAMPLE 51

Synthesis of 2-Acetamido-N-benzyl-2-(ethylamino)acetamido.

Using ethyl 2-acetamido-2-(ethylamino)acetate (0.90 g, 4.79 mmol), benzylamine (0.62 g, 5.75 mmol), and NaCN (0.03 g, 0.51 mmol) gave an oily residue which was purified by flash column chromatography on  $\text{SiO}_2$  gel (3% MeOH/CHCl<sub>3</sub>) to give the desired product as a white solid.

Yield: 0.35 g (29%).

$R_f$  0.34 (4% MeOH/CHCl<sub>3</sub>).

mp 123°–125° C. (recrystallized from ethyl acetate/hexane).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  0.93 (t,  $J$ =6.8 Hz, 3H), 1.81 (s, 3H), 2.08 (br s, 1H), 2.40–2.48 (m, 2H), 4.22 (d,  $J$ =5.5 Hz, 2H), 4.90 (d,  $J$ =7.8 Hz, 1H), 7.20–7.27 (m, 5H), 8.08 (d,  $J$ =7.8 Hz, 1H), 8.48 (t,  $J$ =5.5 Hz, 1H).

<sup>13</sup>C NMR (CDCl<sub>3</sub>) 15.14, 22.97, 37.65, 43.53, 65.68, 127.44 (2 C), 127.50, 128.64 (2 C), 137.73, 169.75, 171.20 ppm.

IR (KBr) 3250, 1620 (br), 1510 (br), 1450 (br), 740, 680  $\text{cm}^{-1}$ .

Elemental analysis Calculated for C<sub>13</sub>H<sub>19</sub>N<sub>3</sub>O<sub>2</sub> 62.63% C; 7.68% H; 16.85% N. Found 62.69% C; 7.49% H; 16.65% N.

#### EXAMPLE 52

Synthesis of 2-Acetamido-N-benzyl-2-(N-anilino)acetamido.

Employing ethyl 2-acetamido-2-(N-anilino)acetate (2.00 g, 8.47 mmol), benzylamine (1.09 g, 10.00 mmol), and NaCN (0.04 g, 0.84 mmol) gave a white solid which separated during the course of the reaction. The precipitate was filtered and purified by recrystallization from absolute EtOH to give the desired product.

Yield: 1.10 g (44%).

mp 183°–185° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.84 (s, 3H), 4.31 (d,  $J$ =5.8 Hz, 2H), 5.67 (t,  $J$ =8.1 Hz, 1H), 6.04 (d,  $J$ =8.1 Hz, 1H), 6.59–6.64 (m, 1H), 6.70–6.72 (m, 2H), 7.06–7.11 (m, 2H), 7.20–7.33 (m, 5H), 8.41 (d,  $J$ =8.1 Hz, 1H), 8.72 (t,  $J$ =5.8 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.46, 42.25, 60.42, 113.21 (2 C), 117.22, 126.72, 127.16 (2 C), 128.18 (2 C), 128.77 (2 C), 138.99, 145.88, 168.65, 169.70 ppm.

IR (KBr) 3270, 1630, 1520, 1490, 1430, 740, 690  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity) 297 (M<sup>+</sup>, 2), 239 (7), 164 (28), 163 (100), 122 (20), 121 (100), 106 (47), 104 (65), 93 (63), 91 (77).

Elemental analysis Calculated for C<sub>17</sub>H<sub>19</sub>N<sub>3</sub>O<sub>2</sub> 68.67% C; 6.44% H; 14.13% N. Found 68.94% C; 6.42% H; 13.92% N.

#### EXAMPLE 53

Synthesis of 2-Acetamido-N-benzyl-2-(N-(3-pyrazolylamino))acetamide.

A solution of ethyl 2-acetamido-2-(N-(3-pyrazolylamino))acetate (1.60 g, 7.1 mmol) in MeOH (40 mL) containing benzylamine (0.83 g, 7.8 mmol) and NaCN (50 mg, 1 mmol) was stirred at 45–55° C. (18 h). TLC analysis (8% MeOH/CHCl<sub>3</sub>) of the reaction mixture indicated the presence of only a minor amount of product. A second lot of NaCN (50 mg, 1 mmol) was then added and the reaction was allowed to proceed at 45–55° C. (6 h) and then at room temperature (48 h). The solvent was removed in vacuo and the residue was triturated with EtOAc (15 mL). The insoluble solid that remained was filtered and purified by flash column chromatography on  $\text{SiO}_2$  gel (7% MeOH/CHCl<sub>3</sub>) to give the desired product.

Yield: 0.90 g (44%).

$R_f$  0.35 (8% MeOH/CHCl<sub>3</sub>).

mp 135°–137° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.82 (s, 3H), 4.29 (d,  $J$ =5.9 Hz, 2H), 5.51–5.55 (m, 3H), 7.18–7.40 (m, 6H), 8.36 (br s, 1H), 8.53 (br s, 1H), 11.66 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.59, 42.29, 61.79, 90.68, 126.67, 127.07 (2 C), 128.17 (2 C), 129.10, 139.41, 153.53, 169.19, 169.67 ppm.

IR (KBr) 3230 (br), 1620 (br), 1500 (br), 1430, 730, 690  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity) 288 (M<sup>+</sup>+1, 64), 287 (M<sup>+</sup>, 2), 230 (28), 229 (100), 153 (46).

Elemental analysis Calculated for C<sub>14</sub>H<sub>17</sub>N<sub>5</sub>O<sub>2</sub>·0.5 H<sub>2</sub>O 56.47% C; 6.12% H; 23.63% N. Found 56.63% C; 5.79% H; 23.43% N.

Preparation of Functionalized  $\alpha$ -Heteroatom Substituted Amino Acids.

General Procedure.

A BBr<sub>3</sub> solution (1M in CH<sub>2</sub>Cl<sub>2</sub>, 1.1 equiv) was added to a solution of 2-acetamido-N-benzyl-2-ethoxyacetamido (1 equiv) in CH<sub>2</sub>Cl<sub>2</sub> (10 mmol/125 mL). The mixture was stirred at room temperature (5 h) and then concentrated to dryness in vacuo to give 2-acetamido-N-benzyl-2-bromoacetamide as in pale yellow crystalline material. The bromo adduct was then dissolved in THF (10 mmol/250 mL), cooled (–78° C.), and then added over a 15 min interval to a cooled (–78° C.) solution of the heteroatom nucleophile in THF (1 mmol/1 mL). The reaction mixture was stirred at this temperature (30 min) and then at room temperature (90 min). The insoluble salts were filtered and the filtrate concentrated in vacuo. The residue was then purified by flash column chromatography on  $\text{SiO}_2$  gel using the indicated solvent as the eluent.

Using this procedure the following examples were prepared.

#### EXAMPLE 54

Synthesis of 2-Acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide.

By making use of 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol), BBr<sub>3</sub> (1M in CH<sub>2</sub>Cl<sub>2</sub>,

13.2 mL, 13.2 mmol), and  $\text{Me}_2\text{NH}$  (5–6 equiv) was obtained a brown residue which was purified by flash column chromatography on  $\text{SiO}_2$  gel (2.5% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was recrystallized from ethyl acetate/hexane to give light yellow cubic crystals.

Yield: 1.20 g (40%).

$R_f$  0.39 (5% MeOH/CHCl<sub>3</sub>).

mp 104°–106° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.91 (s, 3H), 2.11 (s, 6H), 4.22 (dd,  $J$ =5.2, 14.7 Hz, 1H), 4.34 (dd,  $J$ =6.1, 14.7 Hz, 1H), 5.11 (d,  $J$ =8.3 Hz, 1H), 7.23–7.31 (m, 5H), 8.18 (d,  $J$ =8.3 Hz, 1H), 8.55 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.43, 40.33 (2 C), 42.28, 69.42, 126.73, 127.27 (2 C), 128.21 (2 C), 139.49, 168.49, 170.31 ppm.

IR (KBr) 3280, 1670 (br), 1500 (br), 1460, 760, 700  $\text{cm}^{-1}$ .

Mass spectrum 250 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>13</sub>H<sub>19</sub>N<sub>3</sub>O<sub>2</sub> 62.63% C; 7.68% H; 16.85% N. Found 62.82% C; 7.66% H; 16.69% N.

#### EXAMPLE 55

Synthesis of 2-Acetamido-N-benzyl-2-(N-hydroxyamino)acetamide.

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol), BBr<sub>3</sub> (1M in CH<sub>2</sub>Cl<sub>2</sub>, 8.8 mL, 8.8 mmol), and anhydrous NH<sub>2</sub>OH (5–6 equiv) gave an oily residue. The residue was separated into three components by flash chromatography on  $\text{SiO}_2$  gel (7.5% MeOH/CHCl<sub>3</sub>).

2-Acetamido-N-benzyl-2-(N-hydroxyamino)acetamide.

Yield: 0.14 g (7%).

$R_f$  0.30 (8% MeOH/CHCl<sub>3</sub>).

mp 144°–146° C. (dec.) (recrystallized from EtOH).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.88 (s, 3H), 4.31 (d,  $J$ =5.7 Hz, 2H), 5.08 (dd,  $J$ =4.4, 8.1 Hz, 1H), 5.94 (dd,  $J$ =2.8, 4.4 Hz, 1H), 7.19–7.35 (m, 5H), 7.5 (d,  $J$ =2.8 Hz, 1H), 8.26 (d,  $J$ =8.1 Hz, 1H), 8.42 (t,  $J$ =5.7 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.69, 42.25, 67.86, 126.69, 127.14 (2 C), 128.18 (2 C), 139.08, 168.53, 169.67 ppm.

IR (KBr) 3320 (br), 1660 (br), 1540 (br), 1460, 750, 700  $\text{cm}^{-1}$ .

Mass spectrum (FD) 238 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>11</sub>H<sub>15</sub>N<sub>3</sub>O<sub>3</sub> 55.69% C; 6.37% H; 17.71% N. Found 55.86% C; 6.37% H; 17.38% N.

Dimer A.

Yield: 0.05 g (3%).

$R_f$  0.27 (8% MeOH/CHCl<sub>3</sub>).

mp 177°–179° C. (recrystallized from EtOH).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.82 (s, 6H), 4.25–4.34 (m, 4H), 5.21 (d,  $J$ =9.3 Hz, 2H) 7.20–73.3 (m, 10H), 8.16 (d,  $J$ =9.3 Hz, 2H), 8.26 (t,  $J$ =5.8 Hz, 2H), 8.51 (s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.54 (2 C), 42.30 (2 C), 67.55 (2 C), 126.63 (2 C), 127.13 (4 C), 128.11 (4 C), 139.02 (2 C), 168.24 (2 C), 169.33 (2 C) ppm.

IR (KBr) 3240 (br), 1640 (br), 1510 (br), 1450, 690  $\text{cm}^{-1}$ .

Mass spectrum (FD) 442 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>22</sub>H<sub>27</sub>N<sub>5</sub>O<sub>5</sub> 59.85% C; 6.16% H; 15.86% N. Found 59.56% C; 6.08% H; 15.64% N.

Dimer B.

Yield: 0.10 g (6%).

$R_f$  0.18 (8% MeOH/CHCl<sub>3</sub>).

mp 184°–186° C. (recrystallized from MeOH).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.87 (6H), 4.20 (dd,  $J$ =5.3, 15.3 Hz, 2H), 4.44 (dd,  $J$ =6.2, 15.3 Hz, 2H), 5.28 (d,  $J$ =9.0 Hz, 2H), 7.15–7.31 (m, 10H), 8.00 (d,  $J$ =9.0 Hz, 2H), 8.39 (dd,  $J$ =5.3, 6.2 Hz, 2H), 8.51 (s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.50 (2 C), 42.58 (2 C), 69.98 (2 C), 126.73 (2 C), 127.23 (4 C), 128.22 (4 C), 139.08 (2 C), 167.60 (2 C), 169.57 (2 C) ppm.

IR (KBr) 3300 (br), 1660 (br), 1530 (br), 1450, 740, 700  $\text{cm}^{-1}$ .

Mass spectrum (FD) 442 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>22</sub>H<sub>27</sub>N<sub>5</sub>O<sub>5</sub> 59.85% C; 6.16% H; 15.86% N. Found 60.09% C; 5.93% H; 15.76% N.

#### EXAMPLE 56

Improved Synthesis of 2-Acetamido-N-benzyl-2-(N-hydroxyamino)acetamide.

2-Acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol) and BBr<sub>3</sub> (1M in CH<sub>2</sub>Cl<sub>2</sub>, 17.2 mL, 17.2 mmol)) was dissolved in THF (250 mL), cooled (–10° C.), and then added dropwise (30 min) to a suspension of NH<sub>2</sub>OH (5–6 equiv) in THF (50 mL) at –10° C. The reaction mixture was stirred (30 min) at this temperature and then allowed to warm to room temperature (1 h). The insoluble materials were filtered and the filtrate was concentrated in vacuo. The residue was separated into two components by flash column chromatography on  $\text{SiO}_2$  gel (7.5% MeOH/CHCl<sub>3</sub>).

2-Acetamido-N-benzyl-2-(N-hydroxyamino)acetamide.

Yield: 0.66 g (23%).

mp 144°–146° C. (dec.) (recrystallized from EtOH).

Dimer B.

Yield: 0.10 g (5%).

mp 184°–186° C. (recrystallized from MeOH).

Dimer A was not observed under these conditions.

#### EXAMPLE 57

Synthesis of 2-Acetamido-N-benzyl-2-(N<sup>2</sup>-phenylhydrazino)acetamide.

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol), BBr<sub>3</sub> (1M in CH<sub>2</sub>Cl<sub>2</sub>, 10.0 mL, 10.0 mmol), and phenylhydrazine (2.60 g, 24.0 mmol) gave a pale yellow oily residue which was purified by flash column chromatography on  $\text{SiO}_2$  gel (2% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was recrystallized from chloroform/hexane as a light yellow solid.

Yield: 0.75 g (29%).

$R_f$  0.26 (2% MeOH/CHCl<sub>3</sub>).

mp 132°–134° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, 3H), 4.28 (d,  $J$ =5.8 Hz, 2H), 4.89 (d,  $J$ =5.2 Hz, 1H), 5.09 (dd,  $J$ =5.2, 7.4 Hz, 1H), 6.61 (t,  $J$ =7.4 Hz, 1H), 6.70–7.28 (m, 10H), 8.29 (d,  $J$ =7.4 Hz, 1H), 8.60 (t,  $J$ =5.8 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.88, 42.22, 66.22, 112.66 (2 C), 117.57, 126.65, 127.08 (2 C), 128.15 (2 C), 128.53 (2 C), 139.12, 149.90, 168.66, 170.04 ppm.

IR (KBr) 3300, 1640 (br), 1610, 1520 (br), 1460, 760, 700  $\text{cm}^{-1}$ .

Mass spectra (FD) 313 (M<sup>+</sup>+1).

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Elemental analysis Calculated for  $C_{17}H_{20}N_4O_2$  65.37% C; 6.45% H; 17.94% N. Found 65.15% C; 6.25% H; 17.71% N.

## EXAMPLE 58

Synthesis of 2-Acetamido-N-benzyl-2-( $N^2$ -benzyloxycarbonylhydrazino)acetamide.

Employing 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol),  $Br_3$  (1M in  $CH_2Cl_2$ , 15.0 mL, 15.0 mmol), and benzyl carbazate (4.58 g, 27.6 mmol), 0.95 g (21%) of the desired product was obtained. The product was recrystallized from chloroform/hexane to give a white amorphous solid.

$R_f$  0.32 (2% MeOH/CHCl<sub>3</sub>).

mp 152°–154° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, 3H), 4.27 (d,  $J$ =4.4 Hz, 2H), 5.00 (s, 2H), 5.14 (dd,  $J$ =3.1, 8.0 Hz, 1H), 5.23 (t,  $J$ =3.1 Hz, 1H), 7.25–7.35 (m, 10H), 8.26 (d,  $J$ =8.0 Hz, 1H), 8.56 (br s, 1H), 8.66 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.71, 42.23, 65.56, 65.97, 126.69, 127.16 (2 C), 127.61 (2 C), 127.77, 128.13 (2 C), 128.27 (2 C), 136.74, 138.87, 168.04, 169.95 ppm.

IR (KBr) 3325, 1620 (br), 1500 (br), 1440, 740, 680  $cm^{-1}$ .

Mass spectrum (FD) 371 ( $M^+$ +1).

Elemental analysis Calculated for  $C_{19}H_{22}N_4O_4$  61.61% C; 5.99% H; 15.13% N. Found 61.40% C; 6.21% H; 15.39% N.

## EXAMPLE 59

Synthesis of 2-Acetamido-N-benzyl-2-phenoxyacetamide.

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol),  $Br_3$  (1M in  $CH_2Cl_2$ , 15.0 mL, 15.0 mmol), and NaOPh (4.18 g, 30 mmol) gave a brown oily residue which was purified by flash column chromatography on SiO<sub>2</sub> gel using first  $CHCl_3$  and then 2% MeOH/CHCl<sub>3</sub> as the eluents to give the desired product. The compound was recrystallized from chloroform/hexane.

Yield: 0.80 g (22%).

$R_f$  0.58 (3% MeOH/CHCl<sub>3</sub>).

mp 125°–128° C. (softens at 122° C.).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.83 (s, 3H), 4.35 (d,  $J$ =5.7 Hz, 2H), 6.18 (d,  $J$ =9.4 Hz, 1H), 6.94–6.99 (m, 2H), 7.02–7.33 (m, 8H), 8.98 (t,  $J$ =5.7 Hz, 1H), 9.10 (d,  $J$ =9.4 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.54, 42.24, 76.44, 116.09 (2 C), 121.78, 126.84, 127.26 (2 C), 128.25 (2 C), 128.44 (2 C), 138.84, 155.97, 166.63, 170.73 ppm.

IR (KBr) 3300, 1650 (br), 1600, 1530 (br), 1490, 1450, 760, 700  $cm^{-1}$ .

Mass spectrum (FD) 299 ( $M^+$ +1).

Elemental analysis Calculated for  $C_{17}H_{18}N_2O_3$  0.5  $H_2O$  66.43% C; 6.23% H; 9.11% N. Found 66.62% C; 6.23% H; 9.16% N.

## EXAMPLE 60

Synthesis of 2-Acetamido-N-benzyl-2-(methylmercapto)acetamide.

A cooled (–78° C.) solution of Et<sub>3</sub>N (4.85 g, 48.0 mmol) in THF (20 mL) was added to a cooled (–78° C.) solution of 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (4.00 g, 16.0 mmol) and  $Br_3$  (1M in  $CH_2Cl_2$ , 20.0 mL, 20.0 mmol)) in THF (275 mL). A cooled (–78° C.) solution of excess MeSH

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(5–6 equiv) in THF (55 mL) was then added. The reaction mixture was stirred at this temperature (30 min) and then at room temperature (1 h). The insoluble materials were filtered and the filtrate was evaporated to dryness in vacuo. The oily residue obtained was purified by flash column chromatography on SiO<sub>2</sub> gel (2% MeOH/CHCl<sub>3</sub>) to give 1.10 g (27%) of the desired product as a yellow orange oil. The product was purified by a second flash column chromatography on SiO<sub>2</sub> gel (2% MeOH/CHCl<sub>3</sub>) to give 0.72 g of the pure product as a white solid.

$R_f$  0.65 (3% MeOH/CHCl<sub>3</sub>).

mp 155°–157° C.

<sup>1</sup>H NMR (CD<sub>3</sub>NO<sub>2</sub>)  $\delta$  1.98 (s, 3H), 2.08 (s, 3H), 4.39 (dd,  $J$ =6.1, 15.2 Hz, 1H), 4.49 (dd,  $J$ =6.1, 15.2 Hz, 1H), 5.51 (d,  $J$ =7.8 Hz, 1H), 7.15 (d,  $J$ =7.8 Hz, 1H), 7.17–7.41 (m, 6H).

<sup>13</sup>C NMR (CD<sub>3</sub>NO<sub>2</sub>) 12.28, 22.94, 44.26, 56.03, 128.46, 128.60 (2 C), 129.77 (2 C), 140.17, 169.19, 171.06 ppm.

IR (KBr) 3320, 1650 (br), 1520 (br), 1460, 750  $cm^{-1}$ .

Mass spectrum (FD) 253 ( $M^+$ +1).

Elemental analysis Calculated for  $C_{12}H_{16}N_2O_2S$  57.12% C; 6.39% H; 11.10% N. Found 57.06% C; 6.57% H; 11.28% N.

## EXAMPLE 61

Synthesis of 2-Acetamido-N-benzyl-2-(ethylmercapto)acetamide.

Using the procedure described for the synthesis of 2-acetamido-N-benzyl-2-(methylmercapto)acetamide, 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol) and EtSH (0.65 g, 10.4 mmol) were converted to 0.80 g (38%) of the desired product. The compound was further purified by recrystallization from chloroform/hexane to give a beige solid.

$R_f$  0.60 (4% MeOH/CHCl<sub>3</sub>).

mp 146°–148° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.56 (t,  $J$ =7.4 Hz, 3H), 1.88 (s, 3H), 2.49–2.67 (m, 2H), 4.23 (dd,  $J$ =5.9, 15.2 Hz, 1H), 4.32 (dd,  $J$ =5.9, 15.2 Hz, 1H), 5.55 (d,  $J$ =9.1 Hz, 1H), 7.20–7.35 (m, 5H), 8.59 (d,  $J$ =9.1 Hz, 1H), 8.75 (t,  $J$ =5.9 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 14.73, 22.43, 23.73, 42.10, 53.70, 126.87, 127.14 (2 C), 128.32 (2 C), 139.01, 167.89, 169.02 ppm.

IR (KBr) 3240, 1620 (br), 1510 (br), 1415, 680, 640  $cm^{-1}$ .

Mass spectrum (FD) 267 ( $M^+$ +1).

Elemental analysis Calculated for  $C_{13}H_{18}N_2O_2S$  0.25  $H_2O$  57.65% C; 6.88% H; 10.34% N. Found 57.48% C; 6.84% H; 10.28% N.

Preparation of Functionalized  $\alpha$ -Heteroatom Substituted Amino Acids.

General Procedure.

A mixture of 2-acetamido-2-( $N,N,N$ -trimethylammonium)acetamide tetrafluoroborate (1 equiv), and the nitrogen nucleophile (4–5 equiv) in MeOH (1 mmol/1 mL) was stirred at 55°–60° C. (3 h). The solvent was removed in vacuo and the residue was purified by flash column chromatography on SiO<sub>2</sub> gel using the indicated solvents as the eluent.

Using this procedure the following examples were prepared.

## EXAMPLE 62

Synthesis of 2-Acetamido-N-benzyl-2-(N-methoxyamino)acetamide.

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Using a MeOH solution of MeONH<sub>2</sub> (prepared from MeONH<sub>2</sub>.HCl (2.83 g, 33.9 mmol) and NaOMe (1.41 g, 26.1 mmol)), and 2-acetamido-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate (2.70 g, 7.67 mmol) gave an oily residue which was purified by flash column chromatography on SiO<sub>2</sub> gel (2% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was recrystallized from chloroform/hexane.

Yield: 0.80 g (42%).

R<sub>f</sub> 0.23 (2% MeOH/CHCl<sub>3</sub>)  
mp 95°–97° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.88 (s, 3H), 3.38 (s, 3H), 4.22–4.41 (m, 2H), 5.18 (dd, J=4.9, 7.8 Hz, 1H), 6.78 (d, J=4.9 Hz, 1H), 7.21–7.32 (m, 5H), 8.33 (d, J=7.8 Hz, 1H), 8.56 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.64, 42.28, 61.42, 66.25, 126.74, 127.19 (2 C), 128.19 (2 C), 139.11, 167.95, 169.66 ppm.

IR (KBr) 3300, 1650, 1620, 1510 (br), 1440, 750, 680 cm<sup>-1</sup>.

Mass spectrum (FD) 252 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>12</sub>H<sub>17</sub>N<sub>3</sub>O<sub>3</sub> 57.63% C; 6.82% H; 16.72% N. Found 57.06% C; 6.63% H; 16.65% N.

### EXAMPLE 63

#### Synthesis of 2-Acetamido-N-benzyl-2-(N-(N-methylhydroxyamino))acetamide.

An MeOH solution (30 mL) of MeNHOH (21.74 mmol) (prepared from MeNHOH.HCl (2.36 g, 28.26 mmol) and NaOMe (1.17 g, 21.74 mmol)) and 2-acetamido-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate (2.20 g, 6.25 mmol) gave a residue which was purified by flash column chromatography on SiO<sub>2</sub> gel (6% MeOH/CHCl<sub>3</sub>) to give the desired product as a white solid. The product was then purified by recrystallization from EtOH.

Yield: 0.95 g (61%).

R<sub>f</sub> 0.32 (8% MeOH/CHCl<sub>3</sub>)  
mp 159°–161° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.95 (s, 3H), 2.43 (s, 3H), 4.26 (dd, J=5.7, 15.1 Hz, 1H), 4.35 (dd, J=5.7, 1.51 Hz, 1H), 5.09 (d, J=9.1 Hz, 1H), 7.21–7.29 (m, 5H), 8.05 (s, 1H), 8.18 (d, J=9.1 Hz, 1H), 8.23 (t, J=5.7 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.40, 42.34, 43.92, 71.49, 126.62, 127.12 (2 C), 128.12 (2 C), 139.14, 167.82, 170.28 ppm.

IR (KBr) 3440 (br), 3300, 1640, 1530, 1460, 750, 700 cm<sup>-1</sup>.

Mass spectrum (FD) 252 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>12</sub>H<sub>17</sub>N<sub>3</sub>O<sub>3</sub> 57.36% C; 6.82% H; 16.72% N. Found 57.65% C; 6.59% H; 16.66% N.

### EXAMPLE 64

#### Synthesis of 2-Acetamido-N-benzyl-2-(N-(N,O-methylhydroxyamino))acetamide.

An MeOH solution (20 mL) of MeNHOMe (17.39 mmol) (prepared from MeNHOMe.HCl (2.20 g, 23.02 mmol) and NaOMe (0.94 g, 17.39 mmol)) and 2-acetamido-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate (2.10 g, 5.97 mmol) gave a solid residue. Flash column chromatography of the solid on SiO<sub>2</sub> gel (2% MeOH/CHCl<sub>3</sub>) yielded pure desired product. The product was recrystallized from EtOH.

Yield: 1.30 g (82%).

50

R<sub>f</sub> 0.39 (2% MeOH/CHCl<sub>3</sub>).

mp 165°–167° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.93 (s, 3H), 2.43 (s, 3H), 3.32 (s, 3H), 4.25 (dd, J=5.9, 14.9 Hz, 1H), 4.37 (dd, J=5.9, 14.9 Hz, 1H), 5.19 (d, J=9.4 Hz, 1H), 7.21–7.35 (m, 5H), 8.31 (d, J=9.4 Hz, 1H), 8.56 (t, J=5.9 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.36, 39.68, 42.34, 59.16, 70.33, 126.74, 127.41 (2 C), 128.21 (2 C), 139.30, 167.38, 170.30 ppm.

IR (KBr) 3300, 1640 (br), 1540 (br), 1460, 750, 700 cm<sup>-1</sup>.

Mass spectrum (FD) 266 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>13</sub>H<sub>19</sub>N<sub>3</sub>O<sub>3</sub> 58.85% C; 7.22% H; 15.84% N. Found 59.05% C; 7.37% H; 15.75% N.

### EXAMPLE 65

#### Synthesis of 2-Acetamido-N-benzyl-2-(N-isoxazolidino)acetamide.

Using 2-acetamido-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate (1.60 g, 4.55 mmol), isoxazolidine (prepared from isoxazolidine hydrobromide (2.41 g, 15.65 mmol) and NaOMe (0.70 g, 13.04 mmol)) gave the desired product. The product was recrystallized from chloroform/hexane to give a white amorphous solid.

Yield: 0.80 g (64%).

R<sub>f</sub> 0.29 (4% MeOH/CHCl<sub>3</sub>).

mp 149°–151° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.91 (s, 3H), 2.05–2.20 (m, 2H), 2.45–2.89 (m, 1H), 2.98–3.07 (m, 1H), 3.74–3.90 (m, 2H), 4.25 (dd, J=6.1, 15.3 Hz, 1H), 4.35 (dd, J=6.1, 15.3 Hz, 1H), 5.23 (d, J=9.2 Hz, 1H), 7.15–7.35 (m, 5H), 8.49 (d, J=9.2 Hz, 1H), 8.56 (br s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.26, 28.26, 42.15, 48.94, 66.19, 68.77, 126.64, 127.02 (2 C), 128.13 (2 C), 139.22, 167.43, 170.27 ppm.

IR (KBr) 3400 (br), 3300, 1650, 1530, 1470, 740, 700, 610 cm<sup>-1</sup>.

Mass Spectrum (FD) 278 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>14</sub>H<sub>19</sub>N<sub>3</sub>O<sub>3</sub> 60.64% C; 6.91% H; 15.15% N. Found 60.16% C; 7.04% H; 15.07% N.

Preparation of Functionalized  $\alpha$ -Heteroatom Substituted Amino Acids.

General Procedure.

2-Acetamido-N-benzyl-2-ethoxyacetamide (1 equiv) was suspended in Et<sub>2</sub>O (100 mL/100 mmol), and then BF<sub>3</sub>.Et<sub>2</sub>O (1.6–2.4 equiv) was rapidly added and the resulting solution was stirred (10 min). The nucleophile (H<sub>2</sub>O or EtSH) (1.6–4.0 equiv) was then added and the reaction was stirred at room temperature (18–48 h). The reaction was then quenched by the addition of an aqueous NaHCO<sub>3</sub> (100 mL/10 mmol)/ice mixture. The experimental workup varied slightly for each compound and is described in the following examples along with the observed spectral properties.

### EXAMPLE 66

#### Synthesis of 2-Acetamido-N-benzyl-2-hydroxyacetamide.

Reacting 2-acetamido-N-benzyl-2-ethoxyacetamide (1.00 g, 4.0 mmol), BF<sub>3</sub>.Et<sub>2</sub>O (0.91 g, 6.4 mmol) and H<sub>2</sub>O (0.12 g, 6.7 mmol) followed by aqueous NaHCO<sub>3</sub> workup gave an aqueous reaction mixture. The solution was then extracted with EtOAc (3×50 mL), and the combined EtOAc extracts were dried (Na<sub>2</sub>SO<sub>4</sub>), and concentrated in vacuo. The resi-

due was purified by flash column chromatography on  $\text{SiO}_2$  gel (3% MeOH/CHCl<sub>3</sub>) to give the desired product as a white solid.

Yield: 0.30 g (34%).

$R_f$  0.14 (3% MeOH/CHCl<sub>3</sub>).

mp 136°–138° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, 3H), 4.29 (d, J=5.9 Hz, 2H), 5.48 (dd, J=5.5, 8.6 Hz, 1H), 6.47 (d, J=5.5 Hz, 1H), 7.21–7.35 (m, 5H), 8.52 (t, J=5.9 Hz, 1H), 8.59 (d, J=8.6 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.66, 41.99, 71.42, 126.66, 127.22 (2 C), 128.13 (2 C), 139.20, 169.47, 169.62 ppm.

IR (KBr) 3300, 1620, 1530 (br), 1430 (br), 730, 690  $\text{cm}^{-1}$ .

Mass spectrum, m/e (relative intensity) 223 (M<sup>+</sup>+1, 1), 163 (11), 134 (9), 106 (46), 91 (100), 77 (22), 65 (38).

Elemental analysis Calculated for C<sub>11</sub>H<sub>14</sub>N<sub>2</sub>O<sub>3</sub> 59.45% C; 6.35% H; 12.61% N. Found 59.24% C; 6.36% H; 12.50% N.

### EXAMPLE 67

**Synthesis of 2-Acetamido-N-benzyl-2-(ethylmercapto)acetamido.**

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol), BF<sub>3</sub>·Et<sub>2</sub>O (2.72 g, 19.2 mmol) and EtSH (2.38 g, 38.4 mmol) gave an aqueous reaction mixture. The solution was extracted with CHCl<sub>3</sub> (3×100 mL). The combined CHCl<sub>3</sub> layers were dried (Na<sub>2</sub>SO<sub>4</sub>), and then concentrated in vacuo to give the desired product as white solid.

Yield: 1.90 g (89%).

$R_f$  0.60 (4% MeOH/CHCl<sub>3</sub>).

mp 148°–149° C. (mixed melting point with an authentic sample, of Example 61 was undepressed).

### EXAMPLE 68

**Synthesis of 2,2-Diacetamido-N-benzylacetamide.**

Ac<sub>2</sub>O (1 mL) was added to a solution of 2-acetamido-N-benzyl-2-aminoacetamide (1.10 g, 4.98 mmol) in dry pyridine (10 mL) and then CH<sub>2</sub>Cl<sub>2</sub> (20 mL) was added. The mixture was stirred at room temperature (4 h) and then the volatile materials were removed in vacuo. The residue was then treated with a saturated aqueous NaHCO<sub>3</sub> solution (50 mL). The white solid that remained was the desired product and was filtered, dried (Na<sub>2</sub>SO<sub>4</sub>), and recrystallized from MeOH.

Yield: 1.20 g (92%).

mp 265°–267° C. (dec.).

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.84 (s, 6H), 4.26 (d, J=5.8 Hz, 2H), 5.71 (t, J=7.6 Hz, 1H), 7.20–7.31 (m, 5H), 8.44 (d, J=7.6 Hz, 2H), 8.48 (t, J=5.8 Hz, 1H).

<sup>13</sup>C (DMSO-d<sub>6</sub>) 22.44 (2 C), 42.26, 56.99, 126.62, 127.02 (2 C), 128.12 (2 C), 139.15, 168.19, 169.39 (2 C) ppm.

IR (KBr) 3260, 1530, 1500, 740, 690  $\text{cm}^{-1}$ .

Mass spectrum (FD) 264 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>13</sub>H<sub>17</sub>N<sub>3</sub>O<sub>3</sub> 59.30% C; 6.51% H; 15.96% N. 59.16% C; 6.49% H; 15.86% N.

### EXAMPLE 69

**Synthesis of 2-Acetamido-N-benzyl-2-trifluoroacetamidoacetamide.**

Ice cold trifluoroacetic anhydride (8 mL) was added in one portion to ice cold 2-acetamido-N-benzyl-2-aminoacetamide (1.00 g, 4.53 mmol). The reaction was

accompanied by the evolution of heat. After stirring (5 min), the volatile materials were removed in vacuo. The residue was treated with a saturated aqueous NaHCO<sub>3</sub> solution (20 mL), and the solid that remained was filtered and washed with H<sub>2</sub>O to give the desired product. The product was recrystallized from EtOH.

Yield: 1.00 g (70%).

$R_f$  0.34 (8% MeOH/CHCl<sub>3</sub>).

mp 228°–230° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, 3H), 4.30 (d, J=5.1 Hz, 2H), 5.85 (d, J=8.0 Hz, 1H), 7.21–7.35 (m, 5H), 8.64 (d, J=8.0 Hz, 1H), 8.75 (t, J=5.1 Hz, 1H), 10.04 (s, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.52, 42.52, 57.42, 117.4 (q, JCF=288.3 Hz), 126.80, 127.16 (2 C), 128.21 (2 C), 138.93, 156.14 (q, JCF=35.3 Hz), 166.3.9, 169.88 ppm.

IR (KBr) 3300, 1720, 1660, 1520, 1380, 760, 700  $\text{cm}^{-1}$ .

Mass spectrum (FD) 318 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>13</sub>H<sub>14</sub>N<sub>3</sub>O<sub>3</sub>F<sub>3</sub> 49.21% C; 4.45% H; 13.24% N. Found 49.48% C; 4.43% H; 13.10% N.

### EXAMPLE 70

**Synthesis of 2-Acetamido-N-benzyl-2-(N,N,N-trimethylammonium)acetamide Tetrafluoroborate.**

A solution of 2-acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide (1.93 g, 7.76 mmol) in nitromethane (7 mL) was added slowly to an ice cold solution of trimethyloxonium tetrafluoroborate (1.26 g, 8.54 mmol) in nitromethane (6 mL). The reaction mixture was stirred at this temperature (15 min) and then at room temperature (2 h). Anhydrous Et<sub>2</sub>O (~50 mL) was added the reaction mixture and the white solid that separated was filtered, washed with Et<sub>2</sub>O, and dried in vacuo.

Yield: 1.95 g (72%).

mp 171°–173° C. (dec.).

<sup>1</sup>H NMR (CD<sub>3</sub>NO<sub>2</sub>)  $\delta$  2.14 (s, 3H), 3.18 (s, 9H), 4.50 (d, J=5.8 Hz, 2H), 5.70 (d, J=9.3 Hz, 1H), 7.30–7.41 (m, 5H), 7.57 (d, J=9.3 Hz, 1H), 7.70 (br s, 1H).

IR (KBr) 3300, 1680 (br), 1530, 1490, 710  $\text{cm}^{-1}$ .

Mass spectrum (FD) 264 (M<sup>+</sup>).

Elemental analysis Calculated for C<sub>14</sub>H<sub>22</sub>N<sub>3</sub>O<sub>2</sub>BF<sub>4</sub> 47.89% C; 6.31% H; 11.97% N. Found 47.80% C; 6.33% H; 12.00% N.

### EXAMPLE 71

**Synthesis of 2-Acetamido-N-benzyl-2-(ethylmercapto)acetamide-S-oxide.**

A solution of m-chloroperbenzoic acid (1.00 g (~65%), 3.76 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (10 mL) was added dropwise into a stirred, cooled (~10° to –15° C.) CH<sub>2</sub>Cl<sub>2</sub> solution (125 mL) of 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide (1.00 g, 3.76 mmol) under N<sub>2</sub>. The reaction was stirred (30 min) at this temperature and then, the m-chlorobenzoic acid was precipitated as its ammonium salt by passing NH<sub>3</sub> gas over the surface of the reaction solution. The excess NH<sub>3</sub> was removed by passing N<sub>2</sub> gas through the solution (20 min) at room temperature. The ammonium salt was filtered, and the filtrate was concentrated in vacuo. The residue was purified by flash chromatography on  $\text{SiO}_2$  gel (2% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was recrystallized from chloroform/hexane as a white granular solid.

Yield: 0.55 g (52%).

$R_f$  0.23 (2% MeOH/CHCl<sub>3</sub>).

mp 135°–137° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.15 (t, J=7.5 Hz, 3H), 1.99 (s, 3H), 2.49–2.56 (m, 1H), 2.65–2.72 (m, 1H), 4.34 (d, J=5.7 Hz, 2H), 5.55 (d, J=9.5 Hz, 1H), 7.23–7.34 (m, 5H), 8.74 (d, J=9.5 Hz, 1H), 8.77 (t, J=5.7 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 7.03, 22.34, 42.40, 42.47, 67.15, 126.89, 127.27 (2 C), 128.24 (2 C), 138.55, 164.66, 170.18 ppm.

IR (KBr) 3300 (br), 1640 (br), 1510 (br), 1370, 1230, 1100, 1020, 900 cm<sup>–1</sup>.

Mass spectrum (FD) 283 (M<sup>+</sup>+1).

Elemental analysis Calculated for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>S 55.30% C; 6.43% H; 9.92% N. Found 55.17% C; 6.38% H; 9.70% N.

### EXAMPLE 72

Synthesis of 2-Acetamido-N-benzyl-2-(S-ethylmercapto)acetamide-S-oxide.

A solution of NaIO<sub>4</sub> (1.77 g, 8.27 mmol) in H<sub>2</sub>O (20 mL) was added dropwise into a stirred solution of 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide (2.00 g, 7.52 mmol) in MeOH (25 mL). A precipitate appeared rapidly. H<sub>2</sub>O (~30 mL) was added to the mixture to dissolve most of the suspension, and the reaction was stirred (4 h) at room temperature. The reaction was concentrated in vacuo and the remaining aqueous mixture was extracted with CHCl<sub>3</sub> (3×100 mL). The combined CHCl<sub>3</sub> extracts were dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent was removed in vacuo. The oily residue (1.95 g, 92%) solidified on drying in vacuo. NMR analysis (DMSO-d<sub>6</sub>) or the product showed that it was a 2:1 mixture of the two diastereomers of the desired product. The reaction was recrystallized from EtOAc to give nearly pure diastereomer **A** (1.20 g) that was obtained from the m-chloroperbenzoic acid reaction. The EtOAc mother liquor was concentrated and the remaining residue (0.75 g) was recrystallized from ethyl acetate/hexane to give a diastereomeric mixture (0.41 g) of the two diastereomers **A** and **B** in a 2:3 ratio, respectively.

R<sub>f</sub> 0.60 (4% MeOH/CHCl<sub>3</sub>).

mp 135°–137° C. (softens at 117° C.).

IR (KBr) 3300 (br), 1640 (br), 1510 (br), 1370, 1230, 1100, 1020, 900 cm<sup>–1</sup>.

Mass spectrum (FD) 283 (M<sup>+</sup>+1).

Elemental analysis: Calculated for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>S: 55.30% C; 6.43% H; 9.92% N. Found: 55.58% C; 6.49% H; 9.97% N.

The following NMR spectral properties have been assigned to compounds **A** and **B**.

Diastereomer A.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.16 (t, J=7.5 Hz, 3H), 2.00 (s, 3H), 2.49–2.72 (m, 2H), 4.28–4.39 (m, 2H), 5.56 (d, J=9.7 Hz, 1H), 7.21–7.34 (m, 5H), 8.71–8.77 (m, 2H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 7.10, 22.43, 42.48, 42.57, 67.23, 126.98, 127.36 (2 C), 128.33 (2 C), 138.63, 164.73, 170.25 ppm.

Diastereomer B.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.13 (t, J=7.6 Hz, 3H), 1.94 (s, 3H), 2.49–2.72 (m, 2H), 4.28–4.39 (m, 2H), 5.71 (d, J=9.9 Hz, 1H), 7.21–7.34 (m, 5H), 8.83 (d, J=9.9 Hz, 1H), 8.98 (t, J=5.6 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 6.47, 22.43, 41.53, 42.55, 67.90, 126.98, 127.36 (2 C), 128.33 (2 C), 138.39, 164.43, 169.82 ppm.

### EXAMPLE 73

Synthesis of 2-Acetamido-N-benzyl-2-(ethanesulfonyl)acetamide.

An aqueous solution (20 mL) of NaIO<sub>4</sub> (3.00 g, 14.02 mmol) was added to a MeOH solution (20 mL) of 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide (0.95 g, 3.57 mmol). The initial homogeneous solution rapidly became turbid. H<sub>2</sub>O (~10 mL) was then added dropwise until the system became homogeneous. The solution was stirred (18 h) at 50°–60° C. MeOH (50 mL) was added to the reaction solution and the precipitated salt was filtered and washed with MeOH (10 mL). The filtrate was concentrated and the remaining solution was extracted with CHCl<sub>3</sub> (3×50 mL). The combined CHCl<sub>3</sub> extracts were dried (Na<sub>2</sub>SO<sub>4</sub>), and concentrated in vacuo. Time residue was purified by flash chromatography on SiO<sub>2</sub> gel (1% MeOH/CHCl<sub>3</sub>) to give the desired product. The product was further purified by recrystallization from EtOH.

Yield: 0.34 g (32%).

R<sub>f</sub> 0.34 (3% MeOH/CHCl<sub>3</sub>).

mp 161°–163° C.

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.22 (t, J=7.4 Hz, 3H), 1.99 (s, 3H), 3.04–3.24 (m, 2H), 4.31 (dd, J=5.7, 15.3 Hz, 1H), 4.41 (dd, J=5.7, 15.3 Hz, 1H), 5.93 (d, J=9.8 Hz, 1H), 7.22–7.35 (m, 5H), 9.13 (t, J=5.7 Hz, 1H), 9.17 (d, J=9.8 Hz, 1H).

<sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 5.72, 22.27, 42.63, 45.43, 69.14, 127.02, 127.28 (2 C), 128.33 (2 C), 138.16, 161.88, 169.83 ppm.

IR (KBr) 3300, 2940, 2940, 1660, 1520, 1310, 1230, 1120, 900 cm<sup>–1</sup>.

Mass spectrum (FD) 298 (M<sup>+</sup>).

Elemental analysis Calculated for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>4</sub>S 52.33% C; 6.08% H; 9.39% N. Found 52.52% C; 6.06% H; 9.53% N.

### EXAMPLE 74

Synthesis of 2-Acetamido-N-benzyl-2-(N,N,N-trimethylammonium)acetamide Tetrafluoroborate.

A solution of 2-acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide (1.93 g, 7.76 mmol) in nitromethane (7 mL) was added slowly to an ice cold solution of trimethyloxonium tetrafluoroborate (1.26 g, 8.54 mmol) in nitromethane (6 mL). The reaction mixture was stirred at this temperature (15 min) and then at room temperature (2 h). Anhydrous Et<sub>2</sub>O (~50 mL) was added to the reaction mixture and the white solid that separated was filtered, washed with Et<sub>2</sub>O, and dried in vacuo.

Yield: 1.95 g (72%).

mp 171°–173° C. (dec.).

<sup>1</sup>H NMR (CD<sub>3</sub>NO<sub>2</sub>) δ 2.14 (s, 3H), 3.18 (s, 9H), 4.50 (d, J=5.8 Hz, 2H), 5.70 (d, J=9.3 Hz, 1H), 7.30–7.41 (m, 5H), 7.57 (d, J=9.3 Hz, 1H), 7.70 (br s, 1H).

IR (KBr) 3300, 1680 (br), 1530, 1490, 710 cm<sup>–1</sup>.

Mass spectrum (FD) 264 (M<sup>+</sup>).

Elemental analysis

Calculated for C<sub>14</sub>H<sub>22</sub>N<sub>3</sub>O<sub>2</sub>BF<sub>4</sub> 47.89% C; 6.31% H; 11.97% N. Found 47.80% C; 6.33% H; 12.00% N.

### EXAMPLE 75

Synthesis of 2-Acetamido-N-benzyl-2-(1-pyrrole)acetamide.

A solution 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide

(2.00 g, 8.0 mmol) and  $\text{BBr}_3$  (1M  $\text{CH}_2\text{Cl}_2$  solution, 8.8 mL, 8.8 mmol) was prepared in THF (225 mL) and cooled to  $-78^\circ\text{C}$ . It was then added under  $\text{N}_2$  gas atmosphere to a cooled ( $-78^\circ\text{C}$ ) suspension of potassium pyrrole (2.71 g, 25.8 mmol) in THF (25 mL). The reaction mixture was stirred at  $-78^\circ\text{C}$ . (1 h) and then at room temperature (1 h).  $\text{H}$  was then treated with water (10 mL) and acidified with 5% citric acid to pH 4.0 after which it was made basic with aqueous saturated  $\text{Na}_2\text{CO}_3$  solution. The aqueous mixture was extracted with EtOAc ( $2 \times 250$  mL) and the organic layers were dried ( $\text{Na}_2\text{SO}_4$ ). The volatile materials were removed in vacuo and the residue was purified by flash column chromatography on silica gel using 3% MeOH/CHCl<sub>3</sub> as the eluant to give 0.4 g (18%) of the desired product. It was purified by recrystallization from EtOH: mp 182°–184° C.;  $R_f$  0.44 (4% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.91 (s, COCH<sub>3</sub>), 4.30 (d,  $J=5.5$  Hz, CH<sub>2</sub>), 6.01 (s, 2 $\times$ C<sub>3</sub>H), 6.38 (d,  $J=8.7$  Hz, CH), 6.85 (s, 2 $\times$ C<sub>2</sub>H), 7.11–7.35 (m, 5PhH), 8.96 (t,  $J=5.5$  Hz, NH), 9.14 (d,  $J=8.7$  Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.22 (COCH<sub>3</sub>), 42.15 (CH<sub>2</sub>), 62.86 (CH), 107.79 (2C<sub>3</sub>), 119.19 (2C<sub>2</sub>), 126.76 (C<sub>4</sub>), 127.01 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.11 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.34 (C<sub>1</sub>), 166.37 (CONH), 169.41 (COCH<sub>3</sub>) ppm; mass spectrum, m/e (relative intensity) 272 ( $M^++1$ , 22), 271 ( $M^+$ , 100).

Anal. Calcd for C<sub>15</sub>H<sub>17</sub>N<sub>3</sub>O<sub>2</sub>·0.2 H<sub>2</sub>O: C, 65.53; H, 6.37; N, 15.28. Found: C, 65.80; H, 6.22; N, 15.13.

#### EXAMPLE 76

Synthesis of 2-Acetamido-N-benzyl-2-(1-imidazole) acetamide.

Making use of the experimental procedure described in the above experiment, 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol),  $\text{BBr}_3$  (1M  $\text{CH}_2\text{Cl}_2$  solution, 8.8 mL, 8.8 mmol), Et<sub>3</sub>N (1.62 g, 1.60 mmol), and imidazole (0.60 g, 8.8 mmol) gave 0.60 g (30%) of the desired product. It was recrystallized from ethyl acetate/hexane as a beige colored solid: mp 146°–148° C.;  $R_f$  0.7% (MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, COCH<sub>3</sub>), 4.30 (br s, CH<sub>2</sub>), 6.53 (d,  $J=8.0$  Hz, CH), 6.89 (s, C<sub>5</sub>H), 7.12–7.33 (m, C<sub>4</sub>H, 5PhH), 7.69 (s, C<sub>2</sub>H), 9.06 (br s, NH), 9.29 (d,  $J=8.0$  Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.28 (COCH<sub>3</sub>), 42.36 (CH<sub>2</sub>), 61.18 (CH), 117.56 (C<sub>5</sub>), 126.92 (C<sub>4</sub>), 127.16 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.19 (C<sub>4</sub>), 128.26 (2C<sub>2</sub> or 2C<sub>3</sub>), 136.21 (C<sub>2</sub>), 138.27 (C<sub>1</sub>), 165.72 (CONH), 169.77 (COCH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 274 ( $M^++2$ , 12), 273 ( $M^++1$ , 77), 272 (100), 205 (34), 274 (18).

Anal. Calcd for C<sub>14</sub>H<sub>16</sub>N<sub>4</sub>O<sub>2</sub>: C, 61.75; H, 5.92; N, 20.57. Found: C, 61.95; H, 6.09; N, 20.32.

#### EXAMPLE 77

Synthesis of 2-Acetamido-N-benzyl-2-(1-pyrazole) acetamide.

A solution of 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (3.60 g, 14.4 mmol) and  $\text{BBr}_3$  (1M  $\text{CH}_2\text{Cl}_2$  solution, 15.8 mL, 15.8 mmol)) was prepared in THF (250 mL) and cooled to  $-78^\circ\text{C}$ . A solution of triethylamine (2.91 g, 28.8 mmol) in THF (20 mL) was then added to the above solution. This was followed by the addition of THF (30 mL) solution of pyrazole (1.17 g, 17.28 mmol) and the mixture thus obtained was stirred at  $-78^\circ\text{C}$ . (30 min) and room temperature (1 h). The insoluble materials were filtered and the solvents removed from the filtrate in vacuo. The residue was then purified by flash column chromatography on silica gel using 4% MeOH/CHCl<sub>3</sub> as the eluant to give 0.80 g (22%) of the

desired product. It was then recrystallized from EtOAc as a white solid: mp 158°–160° C.;  $R_f$  0.51 (6% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.93 (s, COCH<sub>3</sub>), 4.29 (d,  $J=5.8$  Hz, NH), 6.26 (s, C<sub>4</sub>H), 6.57 (d,  $J=8.8$  Hz, CH), 7.15–7.33 (m, 5PhH), 7.48 (br s, C<sub>5</sub>H), 7.76 (br s, C<sub>3</sub>H), 8.96 (t,  $J=5.8$  Hz, NH), 9.23 (d,  $J=8.8$  Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.41 (COCH<sub>3</sub>), 42.40 (CH<sub>2</sub>), 65.51 (CH), 105.37 (C<sub>4</sub>), 126.87 (C<sub>4</sub>), 127.14 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.25 (2C<sub>2</sub> or 2C<sub>3</sub>), 129.00 (C<sub>5</sub>), 138.59 (C<sub>3</sub>), 139.17 (C<sub>1</sub>), 165.68 (CONH), 169.81 (COCH<sub>3</sub>) ppm; mass spectrum, m/e (relative intensity) 273 ( $M^++1$ , 11), 272 ( $M^+$ , 2), 139 (83), 138 (100), 92 (37).

Anal. Calcd for C<sub>14</sub>H<sub>16</sub>N<sub>4</sub>O<sub>2</sub>: C, 61.75; H, 5.92; N, 20.57. Found: C, 61.95; H, 5.96; N, 20.28.

#### EXAMPLE 78

Synthesis of 2-Acetamido-N-benzyl-2-(1,2,4-triazole) acetamide.

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (4.00 g, 16.0 mmol),  $\text{BBr}_3$  (1M  $\text{CH}_2\text{Cl}_2$  solution, 17.6 mL, 17.6 mmol), Et<sub>3</sub>N (4.85 g, 48.0 mmol), and 1,2,4-triazole (1.43 g, 20.8 mmol), 1.20 g (28%) of the desired product was obtained. It was recrystallized from EtOAc as an amorphous white solid: mp 146°–148° C.;  $R_f$  0.48 (6% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, COCH<sub>3</sub>), 4.32 (br s, CH<sub>2</sub>), 6.70 (d,  $J=7.8$  Hz, CH), 7.21–7.29 (m, 5PhH), 8.01 (s, C<sub>3</sub>H), 8.57 (s, C<sub>5</sub>H), 9.04 (br s, NH), 9.39 (d,  $J=7.8$  Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.39 (COCH<sub>3</sub>), 42.59 (CH<sub>2</sub>), 65.02 (CH), 126.97 (C<sub>4</sub>), 127.25 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.32 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.47 (C<sub>1</sub>), 143.93 (C<sub>5</sub>), 151.50 (C<sub>3</sub>), 164.77 (CONH), 170.23 (COCH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 275 ( $M^++2$ , 12), 274 ( $M^++1$ , 100), 273 (11), 205 (19), 204 (13), 140 (67), 139 (31).

Anal. Calcd for C<sub>13</sub>H<sub>15</sub>N<sub>3</sub>O<sub>2</sub>: C, 57.13; H, 5.53; N, 25.63. Found: C, 57.37; H, 5.66; N, 25.38.

#### EXAMPLE 79

Synthesis of 2-Acetamido-N-benzyl-2-(1-tetrazole) acetamide.

Making use of 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol),  $\text{BBr}_3$  (1M  $\text{CH}_2\text{Cl}_2$  solution, 13.2 mL, 13.2 mmol), Et<sub>3</sub>N (2.42 g, 24.0 mmol), and tetrazole (1.10 g, 15.6 mmol), 0.90 g (27%) of the desired product was obtained as a white solid. It was recrystallized from EtOH: mp 169°–171° C.;  $R_f$  0.22 (4% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.97 (s, COCH<sub>3</sub>), 4.25–4.40 (m, CH<sub>2</sub>), 7.05 (d,  $J=8.4$  Hz, CH), 7.21–7.38 (m, 5PhH), 9.23 (t,  $J=5.5$  Hz, NH), 9.44 (s, C<sub>5</sub>H), 9.69 (d,  $J=8.4$  Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.38 (COCH<sub>3</sub>), 42.78 (CH<sub>2</sub>), 63.62 (CH), 127.10 (C<sub>4</sub>), 127.39 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.38 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.26 (C<sub>1</sub>), 143.67 (C<sub>5</sub>), 163.88 (CONH), 170.62 (COCH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 275 ( $M^++2$ , 79), 273 (14), 206 (100), 205 (50).

Anal. Calcd for C<sub>14</sub>H<sub>16</sub>N<sub>6</sub>O<sub>2</sub>: C, 52.55; H, 5.15; N, 30.64. Found: C, 52.75; H, 5.33; N, 30.64.

#### EXAMPLE 80

Preparation of  $\alpha$ -acetamido-N-benzyl-2-pyridylacetamide and 2-acetamido-N-benzyl-2-(2'-pyridone)acetamide.

Preparation of 2-acetamido-2-bromo-N-benzylacetamide. A solution of 2-acetamido-2-ethoxy-N-benzylacetamide (2.00 g, 8 mmol) in dry  $\text{CH}_2\text{Cl}_2$  (200 mL) was stirred at room temperature as a solution of  $\text{BBr}_3$  (8.8 mL, 8.8 mmol, 1.0M in  $\text{CH}_2\text{Cl}_2$ ) was introduced by means of a syringe under a nitrogen atmosphere. A white mist formed and after it disappeared, the  $\text{N}_2$  line was removed and the reaction

sealed. The resulting yellow solution was stirred (3.5 h) and then concentrated in vacuo to give yellow crystals of  $\alpha$ -acetamido-2-bromo-N-benzyl acetamido which was stored under vacuum overnight.

Preparation of 2-pyridyllithium.

The generation of 2-pyridyllithium in situ was run under nitrogen. A solution of n-butyllithium (7.2 mL, 2.5M solution in hexane, 18 mmol) was added to dry ether (60 mL), cooled to  $-20^\circ$  C., and stirred as 2-bromopyridine (1.6 mL, 17 mmol) in dry ether (15 mL) was added dropwise (15 min). The resulting blood red solution was stirred at  $-20^\circ$  C. for an additional 5 minutes and then transferred through a doubled-ended needle under a stream of nitrogen to an addition funnel where it was cooled to  $-78^\circ$  C.

Preparation of  $\alpha$ -acetamido-N-benzyl-2-pyridylacetamide and 2-acetamido-N-benzyl-2-(2'-pyridone)acetamide.

The cooled 2-pyridyllithium solution was added dropwise (approximately 2 drops per second) to the solution of 2-acetamido-2-bromo-N-benzylacetamide in dry THF (200 mL) and maintained at  $-78^\circ$  C. The reaction mixture was stirred for an additional 30–45 minutes at  $-78^\circ$  C. The reaction was quenched with saturated aqueous solution of  $\text{NH}_4\text{Cl}$  (40 mL) at  $-78^\circ$  C. producing a heterogenous mixture  $\text{Na}_2\text{CO}_3$  was added dropwise until the precipitate dissolved. The organic layer was separated and then the aqueous layer was extracted with ether (2 $\times$ 50 mL). The combined organic layers were dried ( $\text{Na}_2\text{SO}_4$ ), concentrated under vacuum and separated using flash chromatography on silica gel with ethyl acetate as the eluent. The fractions containing the products were concentrated under vacuum, separated and then further purified by column chromatography on alumina (80–200 mesh, Grade 1, Fisher) employing ethyl acetate as the solvent. Fractions containing  $\alpha$ -acetamido-N-benzyl-2-pyridylacetamide was concentrated to dryness and gave a white amorphous solid (250 mg, 11% yield);  $R_f$  = 0.39 (5%  $\text{CH}_3\text{OH}/\text{CHCl}_3$ ); mp 146°–147° C.; IR (KBr) 3290, 3180, 3020, 1620 br, 1580, 1520 br, 1480, 1420, 1370, 1310, 1260  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{DMSO-d}_6$ )  $\delta$  1.96 (s, 3H), 4.28 (d,  $J=5.8$  Hz, 2H), 5.59 (d,  $J=8.0$  Hz, 1H), 7.18–7.30 (m, 5H), 7.32 (dd,  $J=7.7$ , 5.2 Hz, 1H), 7.47 (d,  $J=7.7$  Hz, 1H), 7.80 (dt,  $J=7.7$ , 1.5 Hz, 1H), 8.55 (m, 2H), 8.78 (br t,  $J=5.8$  Hz, 1H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{DMSO-d}_6$ ) 22.5, 42.1, 58.3, 121.7, 122.8, 126.6, 126.9 (2C), 128.1 (2C), 136.8, 139.1, 148.6, 157.2, 169.0, 169.2 ppm; FD (Lilly) mass spectrum, m/e (relative intensity) 284 ( $\text{M}^++1$ , 6), 283 ( $\text{M}^+$ , 0.8), 151 (8), 150 (100), 141 (4).  $\text{C}_{16}\text{H}_{17}\text{N}_3\text{O}_2$

Anal. Calcd for C 67.83, H, 6.05, N, 14.83

Found: C, 68.11, H, 6.00, N, 14.89.

Fractions containing 2-acetamido-N-benzyl-2-(2'-pyridone)acetamide were combined, concentrated in vacuo and yielded a white amorphous solid: (150 mg, 6% yield).  $R_f$  0.34 (5%  $\text{CH}_3\text{OH}/\text{CHCl}_3$ ); mp 226 decomposed (recrystallized in ethanol)  $^1\text{H}$  NMR (300 MHz,  $\text{DMSO-d}_6$ )  $\delta$  1.94 s, 4.26 (dd,  $J=15.2$ , 5.7 Hz, 1H), 4.33 (dd,  $J=15.2$ , 6.1 Hz, 1H), 6.26 (br t,  $J=6.8$  Hz, 1H), 6.37 (br d,  $J=9.1$  Hz, 1H), 6.69 (d,  $J=8.7$  Hz, 1H), 7.22–7.33 (m, 5H), 7.42 (ddd,  $J=9.1$ , 6.8, 1.6 Hz, 1H), 7.58 (dd,  $J=6.8$ , 1.6 Hz, 1H), 8.93 (br t,  $J=5.8$  Hz, 1H), 9.20 (d,  $J=8.7$  Hz, 1H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{DMSO-d}_6$ ) 22.5, 42.5, 62.5, 105.1, 119.4, 126.80, 127.10 (2C), 128.2 (2C), 135.6, 138.8, 140.2, 161.2, 166.0, 170.0 ppm. Hydrogen and carbon assignments were verified with  $^1\text{H}$ - $^1\text{H}$  COSY,  $^1\text{H}$ - $^{13}\text{C}$ -COSY, zero quantum NMR experiments. The structure was confirmed by X-ray crystallography.

Preparation of authentic 2-acetamido-N-benzyl-2-(2'-pyridone)acetamide.

The generation of 2-hydroxypyridylsodium in situ was done under anhydrous conditions. A solution of 2-hydroxypyridine (1.57 g, 16 mmol, vacuum dried, 97% Aldrich) in dry THF (200 mL) was stirred and cooled to  $0^\circ$  C. and then NaH (0.77 g, 60% in mineral oil, 19.2 mmol) was added in one portion leading to the evolution of  $\text{H}_2$  and the generation of a heterogeneous mixture. A solution of 2-acetamido-2-bromo-N-benzylacetamide (8 mmol based on 2-acetamido-2-ethoxy-N-benzylacetamide) in dry THF (160 mL) was then transferred through a double-ended needle by means of a stream of nitrogen. The resulting mixture was quenched with saturated aqueous solution of  $\text{NH}_4\text{Cl}$  (50 mL) at  $0^\circ$  C. producing a white precipitate. A saturated aqueous solution  $\text{Na}_2\text{CO}_3$  was added dropwise while stirring at  $0^\circ$  C. until all of the white precipitate dissolved. The two layers were separated while cold and then the aqueous fraction was extracted with THF (2 $\times$ 100 mL). The combined organic layers were dried ( $\text{Na}_2\text{SO}_4$ ), and concentrated to dryness. The crude reaction mixture residue was dissolved in a minimum of  $\text{CHCl}_3$  and was flash chromatographed on a silica gel column using ethyl acetate as the eluent and gave a white amorphous solid (1.10 g, 46% yield) which was identical to properties previously observed for 2-acetamido-N-benzyl-2-(2'-pyridone)acetamide:  $R_f$  0.34 (5%  $\text{CH}_3\text{OH}/\text{CHCl}_3$ ); mp 162°–163.5° C. (recrystallized in ethyl acetate); IR (KBr) 3300, 3280, 3260, 3080, 1690, 1680, 1650 br, 1580, 1570, 1520, 1490, 1140  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{DMSO-d}_6$ )  $\delta$  1.96 (s, 3H), 4.27 (dd,  $J=15.3$ , 5.8 Hz, 1H), 4.36 (dd,  $J=15.3$ , 6.2 Hz, 1H), 6.27 (dr,  $J=6.8$ , 1.1 Hz, 1H), 6.39 (bd,  $J=8.9$  Hz, 1H), 6.71 (d,  $J=8.7$  Hz, 1H), 7.22–7.34 (m, 5H), 7.43 (ddd,  $J=8.9$ , 6.8, 1.9 Hz, 1H), 7.59 (dd,  $J=6.8$ , 1.9 Hz, 1H), 8.93 (br t,  $J=5.9$  Hz, 1H), 9.20 (d,  $J=8.7$  Hz, 1H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{DMSO-d}_6$ ) 22.4, 42.5, 62.5, 105.1, 119.4, 126.8, 127.1 (2C), 128.2 (2C), 135.6, 138.8, 140.1, 161.1, 166.0, 169.9 ppm; FD (Lilly) mass spectrum m/e (relative intensity) 598 (2M, 2), 300 ( $\text{M}^++1$ , 17), 299 ( $\text{M}^+$ , 100), 96 (2), 95 (26).  $\text{C}_{16}\text{H}_{17}\text{N}_3\text{O}_3$ . Anal. Calcd for C, 64.20, H, 5.73, N, 14.04.

### EXAMPLE 81

#### $\alpha$ -acetamido-N-benzyl-2-pyridyl acetamide N-oxide

To a cooled solution of 2- $\alpha$ -acetamido-N-benzyl-2-pyridylacetamide dissolved in dry THF is added m-perchloroperbenzoic acid to give the resulting product.

Similarly, using the procedure described hereinabove, the following examples are prepared.

#### 2-acetamido-N-benzyl-2-(3-pyridyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(4-pyridyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(2-pyrimidinyl)acetamide and the N-oxide thereof

2-acetamido-N-benzyl-2-(5-pyrimidinyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(3-pyridazinyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(4-pyridazinyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(4-pyrazinyl)acetamide and the N-oxide thereof,

2-acetamido-N-benzyl-2-(2-thiazolyl)acetamide,

2-acetamido-N-benzyl-2-(2-oxazolyl)acetamide,

2-acetamido-N-benzyl-2-(3-isoxazolyl)acetamide,

2-acetamido-N-benzyl-2-(5-isoxatolyl)acetamide,

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2-acetamido-N-benzyl-2-(3-isothiazolyl)acetamide, and 2-acetamido-N-benzyl-2-(5-isothiazolyl)acetamide.

General Procedure.

2-Acetamido-N-benzyl-2-ethoxyacetamide (1 equiv.) was suspended in anhydrous ethyl ether, and then boron trifluoride etherate (1.6-6.3 equiv.) was rapidly added and the resulting solution was stirred for 15 min. The aromatic substrate (1.6-16 equiv.) was then added and the reaction was stirred at room temperature (1-7 days).

EXAMPLE 82

$\alpha$ -Acetamido-N-benzyl-2-(S-thiophenoxy)-acetamide (II).

The reaction mixture was treated with an aqueous saturated  $\text{NaHCO}_3$  solution and the white insoluble solid was filtered and then washed successively with  $\text{H}_2\text{O}$  and hexanes. The desired product was purified by recrystallization from chloroform hexanes to give II in 94% yield:  $R_f$  0.43 (97:3 chloroform/methanol); m.p. 165°-167°; i.r. (KBr) 3280, 1630 (br), 1520 (br), 1430, 1365, 1280, 1245, 1180  $\text{cm}^{-1}$ ;  $^1\text{H}$  n.m.r. (DMSO- $d_6$ ) 81.83 (s,  $\text{CH}_3\text{CO}$ ), 4.22-4.36 (m,  $\text{CH}_2$ ), 5.90 (d,  $J=9.0$  Hz, NH), 8.84 (t,  $J=5.4$  Hz, NH);  $^{13}\text{C}$  n.m.r. (DMSO- $d_6$ ) 22.34 ( $\text{CH}_3\text{CO}$ ), 42.25 ( $\text{CH}_2$ ), 57.65 (CH), 126.86 ( $\text{C}_4'$ ), 127.20 ( $2\text{C}_2'$ ) 123.73 ( $\text{C}_4'$ ), 128.28 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 128.88 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 132.36 ( $2\text{C}_3'$ ), 132.51 ( $\text{C}_1'$ ), 138.76 ( $\text{C}_1'$ ), 167.09 (CONH) 168.97 ( $\text{CH}_3\text{CO}$ ) ppm; mass spectrum, m/e (relative intensity) 315 ( $M+1, 1$ ), 205 (17), 163 (40), 138 (8), 110 (90), 109 (29), 106 (96), 93 (35), 91 (100).

Anal. calc. for  $\text{C}_{17}\text{H}_{18}\text{N}_2\text{O}_2\text{S}$ : C 64.94, H 5.77. Found: C 65.27, H 5.54.

EXAMPLE 83

Synthesis of  $\alpha$ -Acetamido-N-benzyl-2-(tetrahydrofuran) acetamide (3).

A methanolic solution (70 mL) of  $\alpha$ -acetamido-N-benzyl-2-furanacetamide (3.50 g, 12.85 mmol) was hydrogenated (35-40 psi) in the presence of Pd/C (10%, 0.44 g) (44 h). The catalyst was filtered through celite, washed with MeOH (10 mL) and the filtrate concentrated to dryness in vacuo to give 3a and 3b (3.50 g) as a white solid. The products were fractionally recrystallized from EtOAc to give 1.30 g (37%) of 3a: mp 159°-161° C.;  $R_f$  0.38 (6% MeOH/CHCl<sub>3</sub>); IR (KBr) 3340 (br), 3000, 1600, 1550 (br), 1420, 1350, 720, 680  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.66-1.90 (m,  $\text{C}_3\text{H}_2$ ,  $\text{C}_4\text{H}_2$ ), 1.85 ( $\text{C}(\text{O})\text{CH}_3$ ), 3.62-3.68 (m,  $\text{C}_5\text{HH}'$ ), 3.75-3.80 (m,  $\text{C}_5\text{HH}'$ ), 3.98-4.00 (m,  $\text{C}_2\text{H}$ ), 4.26-4.38 (m, CH,  $\text{CH}_2$ ), 7.18-7.32 (m, 5 PhH), 8.11 (d,  $J=8.8$  Hz, NH), 8.52 (t,  $J=5.8$  Hz, NH);  $^{13}\text{C}$  NMR (DMSO- $d_6$ ) 22.52 ( $\text{C}(\text{O})\text{CH}_3$ ), 24.78 ( $\text{C}_3$ ), 27.82 ( $\text{C}_4$ ), 41.96 ( $\text{CH}_2$ ), 55.67 (CH), 67.54 ( $\text{C}_3$ ), 78.48 ( $\text{C}_2$ ), 126.58 ( $\text{C}_4'$ ), 127.97 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 128.12 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 139.27 ( $\text{C}_1'$ ), 169.09 ( $\text{C}(\text{O})\text{NH}$ ), 170.09 ( $\text{C}(\text{O})\text{CH}_3$ ) ppm; mass spectrum m/e (relative intensity) 277 ( $M+1, 4$ ), 206 (52), 142 (13), 106 (38), 91 (100), 71 (97). Anal. ( $\text{C}_{15}\text{H}_{20}\text{N}_2\text{O}_3$ ) C, H, N.

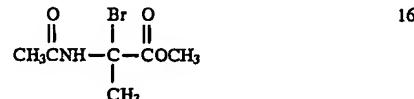
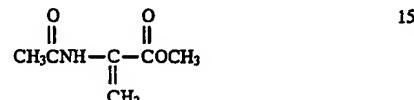
The remaining EtOAc mother liquor after recrystallization was concentrated to half its volume and hexane was added dropwise while heating until the solution became turbid. A white solid (0.65 g, 18%) separated on cooling and was collected by filtration to give diastereoisomer 3b: mp 130°-132° C.;  $R_f$  0.38 (6% MeOH/CHCl<sub>3</sub>);  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.55-1.86 (m,  $\text{C}_3\text{H}_2$ ,  $\text{C}_4\text{H}_2$ ), 1.89 ( $\text{C}(\text{O})\text{CH}_3$ ), 3.55-3.64 (m,  $\text{C}_5\text{HH}'$ ), 3.70-3.78 (m,  $\text{C}_5\text{HH}'$ ), (s, 4.08-4.11 (m,  $\text{C}_2\text{H}$ ), 4.27 (d,  $J=5.8$  Hz,  $\text{CH}_2$ ), 4.36 (dd,  $J=4.7, 8.6$  Hz, CH), 7.21-7.32 (m, 5 PhH), 7.94 (d,  $J=8.6$  Hz, NH), 8.39 (t,  $J=5.8$  Hz, NH);  $^{13}\text{C}$  NMR (DMSO- $d_6$ ) 22.45 ( $\text{C}(\text{O})\text{CH}_3$ ), 25.16 ( $\text{C}_4$ ), 27.53 ( $\text{C}_3$ ), 42.04 ( $\text{CH}_2$ ), 55.48 (CH), 67.53 ( $\text{C}_5$ ),

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78.26 ( $\text{C}_2$ ), 126.59 ( $\text{C}_4'$ ), 127.04 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 128.10 ( $2\text{C}_2'$  or  $2\text{C}_3'$ ), 139.21 ( $\text{C}_1'$ ), 169.55 ( $\text{C}(\text{O})\text{NH}$ ), 169.79 ( $\text{C}(\text{O})\text{CH}_3$ ) ppm; mass spectrum m/e (relative intensity) 277 ( $M+1, 4$ ), 206 (50), 142 (23), 106 (39), 1 (100), 71 (96). Anal. ( $\text{C}_{15}\text{H}_{20}\text{N}_2\text{O}_3$ ) C, H, N.

EXAMPLE 84

Synthesis of Methyl  $\alpha$ -Acetamido-2-methyl-2-furanacetate (17). HBr was bubbled (2.5 min) through a CDCl<sub>3</sub> solution (25 mL) of 15 (3.80 g, 26.6 mmol). The excess HBr and CDCl<sub>3</sub> were removed by evaporating the solution with a continuous stream of Ar (20-30 min). The light yellow oily residue that remained containing 16 was dissolved in THF (100 mL), and then furan (32.76 g, 482.0 mmol) and ZnCl<sub>2</sub> (1M in ether, 53.0 mL, 53.0 mmol) were added. The reaction was stirred at room temperature (3.5 h) and then treated with H<sub>2</sub>O (50 mL). The aqueous mixture was extracted with EtOAc (3×100 mL), and the combined extracts were dried (Na<sub>2</sub>SO<sub>4</sub>). The volatile materials were removed by distillation in vacuo to give 5.00 g (89%) of 17:  $R_f$  0.35 (50%, EtOAc/CHCl<sub>3</sub>);  $^1\text{H}$  NMR (CDCl<sub>3</sub>)  $\delta$  1.94 (s,  $\text{CH}_3$ ), 1.99 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 3.74 (s,  $\text{C}(\text{O})\text{OCH}_3$ ), 6.36 (br s,  $\text{C}_3\text{H}$ ,  $\text{C}_4\text{H}$ ), 6.83 (s, NH), 7.35 (s,  $\text{C}_5\text{H}$ );  $^{13}\text{C}$  NMR (CDCl<sub>3</sub>) 21.43 ( $\text{CH}_3$ ), 23.26 ( $\text{C}(\text{O})\text{CH}_3$ ), 53.03 ( $\text{C}(\text{O})\text{OCH}_3$ ), 58.36 ( $\text{C}(\text{O}H_3)$ ), 107.39 ( $\text{C}_4$ ), 110.52 ( $\text{C}_3$ ), 142.10 ( $\text{C}_5$ ), 152.03 ( $\text{C}_2$ ), 169.21 ( $\text{C}(\text{O})\text{CH}_3$ ), 171.34 ( $\text{C}(\text{O})\text{OCH}_3$ ) ppm.



EXAMPLE 85

Synthesis of  $\alpha$ -Acetamido-2-methyl-2-furanacetic Acid (18).

A 95% EtOH solution (150 mL) of 17 (5.00 g, 23.6 mmol) and KOH (3.00 g, 53.5 mmol) was stirred at room temperature (48 h). The solvent was removed and the residue was dissolved in H<sub>2</sub>O (50 mL). The aqueous solution was washed with Et<sub>2</sub>O (3×50 mL) and then acidified to pH 1.5 with 10% H<sub>3</sub>PO<sub>4</sub>. The acidified solution was extracted with EtOAc (3×200 mL) and the combined extracts were dried (Na<sub>2</sub>SO<sub>4</sub>), and concentrated in vacuo to give 2.90 g (62%) of 18: mp 178°-180° C. (d) (recrystallized from CH<sub>3</sub>CN); IR (KBr) 3400 (br), 1700 (br)  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  1.67 (s,  $\text{CH}_3$ ), 1.83 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 6.39 (m,  $\text{C}_3\text{H}$ ,  $\text{C}_4\text{H}$ ), 7.59 (s,  $\text{C}_5\text{H}$ ), 8.34 (s, NH), 12.63 (s,  $\text{C}(\text{O})\text{OH}$ );  $^{13}\text{C}$  NMR (DMSO- $d_6$ ) 22.20 ( $\text{C}(\text{O})\text{CH}_3$ ), 22.59 ( $\text{CH}_3$ ), 57.65 ( $\text{C}(\text{CH}_3)$ ), 107.09 ( $\text{C}_4$ ), 110.49 ( $\text{C}_3$ ), 142.33 ( $\text{C}_5$ ), 153.36 ( $\text{C}_2$ ), 168.86 ( $\text{C}(\text{O})\text{NH}$ ), 171.78 ( $\text{C}(\text{O})\text{OH}$ ) ppm; mass spectrum, m/e (relative intensity) 198 ( $M+1, 4$ ), 143 (97), 152 (63), 140 (23), 111 (73), 110 (100), 94 (24). Anal. ( $\text{C}_9\text{H}_{11}\text{NO}_4$ ) C, H, N.

EXAMPLE 86

Synthesis of  $\alpha$ -Acetamido-N-benzyl-2-methyl-2-furanacetamide (4).

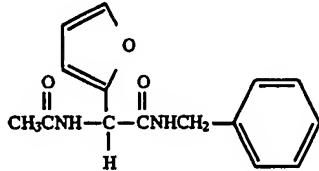
Employing the mixed carbonic anhydride coupling procedure with 18 (2.40 g, 12.2 mmol), 4-methylmorpholine (1.23 g, 12.2 mmol), isobutylchloroformate (1.83 g, 13.4 mmol), and benzylamine (1.43 g, 12.7 mmol) gave 4 (1.50

g, 43%) as a thick oil:  $R_f$  0.29 (2% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (CDCl<sub>3</sub>)  $\delta$  1.94 (s, CH<sub>3</sub>), 1.98 (s, C(O)CH<sub>3</sub>), 4.40 (d, J=5.6 Hz, CH<sub>2</sub>), 6.20 (br s, NH), 6.34–6.37 (m, C<sub>3</sub>H, C<sub>4</sub>H), 7.05–7.36 (m, NH, C<sub>5</sub>H, 5 PhH); <sup>13</sup>C NMR (CDCl<sub>3</sub>) 22.31 (C(O)CH<sub>3</sub>), 23.81 (CH<sub>3</sub>), 43.77 (CH<sub>2</sub>), 58.50 (C(CH<sub>3</sub>)), 107.94 (C<sub>4</sub>), 110.67 (C<sub>3</sub>), 126.99 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 127.41 (C<sub>4</sub>'), 128.60 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 137.52 (C<sub>1</sub>'), 142.38 (C<sub>5</sub>), 152.94 (C<sub>2</sub>), 169.03 (C(O)NH), 171.16 (COCH<sub>3</sub>) ppm; mass spectrum, m/e (relative intensity) 287 (M<sup>+</sup>+1, 4), 228 (4), 153 (99), 152 (96), 138 (15), 111 (63), 110 (100), 91 (75); M<sub>r</sub> (EI) 286.13074 (calcd for C<sub>16</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>, 286.13174).

## EXAMPLE 87

Synthesis of  $\alpha$ -Thioacetamido-N-benzyl-2-furanacetamide (5).

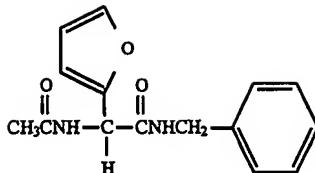
A THF solution (80 mL) of 2 (1.00 g, 3.68 mmol) and Lawesson's reagent (0.73 g, 1.84 mmol) was stirred at room temperature (4 h). The THF was removed in vacuo and the residue was purified by flash column chromatography on SiO<sub>2</sub> gel using 1% MeOH/CHCl<sub>3</sub> to give 0.75 g (71%) of 5: mp 78°–80° C.;  $R_f$  0.51 (1% MeOH/CHCl<sub>3</sub>); IR (KBr) 3200 (br), 1630, 1500, 1440, 1350, 790, 710, 680 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  2.46 (s, C(S)CH<sub>3</sub>), 4.27–4.35 (m, CH<sub>2</sub>), 6.22 (d, J=7.7 Hz, CH), 6.32 (d, J=3.3 Hz, C<sub>3</sub>H), 6.41–6.44 (m, C<sub>4</sub>H), 7.15–7.33 (m, 5 PhH), 7.64 (s, C<sub>5</sub>H), 8.81 (t, J=5.9 Hz, NH), 10.54 (d, J=7.7 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 32.70 (s, C(S)CH<sub>3</sub>), 42.39 (C<sub>2</sub>), 56.82 (CH), 108.76 (C<sub>2</sub>), 110.67 (C<sub>4</sub>), 126.81 (C<sub>4</sub>'), 127.12 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.23 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 139.98 (C<sub>1</sub>'), 143.06 (C<sub>3</sub>), 149.53 (C<sub>2</sub>), 166.55 (C(O)NH), 200.68 (C(S)CH<sub>3</sub>) ppm; mass spectrum (FD) 288 (M<sup>+</sup>). Anal. (C<sub>15</sub>H<sub>16</sub>N<sub>2</sub>O<sub>2</sub>S) C, H, N.



## EXAMPLE 88

Synthesis of  $\alpha$ -Thioacetamido-N-benzyl-2-furanthioacetamide (6).

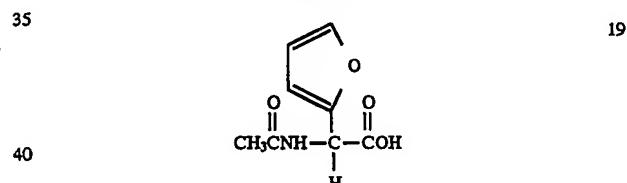
A THF solution (90 mL) of 2 (2.00 g, 7.35 mmol) and Lawesson's reagent (3.27 g, 8.09 mmol) was heated to reflux (4 h). The THF was removed in vacuo and the residue was purified by two successive flash column chromatographies on SiO<sub>2</sub> gel using 0.5% MeOH/CHCl<sub>3</sub> as the eluent in the first chromatography and CHCl<sub>3</sub> in the second chromatography. Compound 6 (0.50 g, 22%) was then further purified by preparative TLC (CHCl<sub>3</sub>): mp 99°–101° C.;  $R_f$  0.74 (1% MeOH/CHCl<sub>3</sub>); IR (KBr) 3100, 1580, 1500 (br) cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  2.58 (s, C(S)CH<sub>3</sub>), 4.86 (dd, J=5.4, 15.0 Hz, CHH), 4.96 (dd, J=5.4, 15.0 Hz, CHH), 6.49–6.55 (m, C<sub>3</sub>H, C<sub>4</sub>H), 6.65 (d, J=7.5 Hz, CH), 7.31–7.43 (m, 5 PhH), 7.75 (s, C<sub>5</sub>H) 10.64 (d, J=7.5 Hz, NH), 10.95 (t, J=5.4 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 32.79 (s, C(S)CH<sub>3</sub>), 48.30 (CH<sub>2</sub>), 61.88 (CH), 108.50 (C<sub>3</sub>), 110.53 (C<sub>4</sub>), 127.05 (C<sub>4</sub>'), 127.48 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.19 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 136.67 (C<sub>1</sub>'), 142.91 (C<sub>3</sub>), 150.15 (C<sub>2</sub>), 197.45 (C(S)NH), 200.56 (C(S)CH<sub>3</sub>) ppm; mass spectrum (FD) 304 (M<sup>+</sup>). Anal. (C<sub>15</sub>H<sub>16</sub>N<sub>2</sub>OS<sub>2</sub>) C, H, N.



## EXAMPLE 89

Synthesis of  $\alpha$ -Acetamido-N-(3-pyridinylmethyl)-2-furanacetamide (7).

Using racemic 19 (3.00 g, 16.39 mmol), 4-methylmorpholine (1.66 g, 16.39 mmol), isobutylchloroformate (2.24 g, 16.39 mmol), and 3-aminomethylpyridine (1.77 g, 16.39 mmol) in the mixed carbonic anhydride protocol gave 3.35 g (75%) of 7: mp 172°–174° C. (recrystallized from EtOAc);  $R_f$  0.27 (8% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 3300, 1640, 1540, 1420, 1360, 820, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.32 (d, J=5.8 Hz, CH<sub>2</sub>), 5.55 (d, J=7.9 Hz, CH), 6.28–6.29 (m, C<sub>3</sub>H), 6.41–6.43 (m, C<sub>4</sub>H), 7.32 (dd, J=4.8, 7.7 Hz, C<sub>5</sub>H), 7.58–7.62 (m, C<sub>4</sub>H, C<sub>5</sub>H), 8.44 (br s, C<sub>2</sub>H, C<sub>6</sub>H), 8.62 (d, J=7.9 Hz, NH), 8.81 (t, J=5.8 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.31 (C(O)CH<sub>3</sub>), 39.98 (CH<sub>2</sub>), 50.94 (CH), 107.67 (C<sub>4</sub>), 110.54 (C<sub>3</sub>), 123.38 (C<sub>5</sub>'), 134.57 (C<sub>3</sub>'), 134.83 (C<sub>4</sub>'), 142.64 (C<sub>5</sub>), 148.06 (C<sub>6</sub>'), 148.55 (C<sub>2</sub>'), 150.94 (C<sub>2</sub>), 168.19 (C(O)NH), 169.26 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 274 (M<sup>+</sup>+1). Anal. (C<sub>14</sub>H<sub>15</sub>N<sub>3</sub>O<sub>3</sub>) C, H, N.

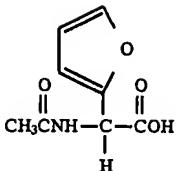


## EXAMPLE 90

Synthesis of  $\alpha$ -Acetamido-N-(4-pyridinylmethyl)-2-furanacetamide (8).

Making use of racemic 19 (3.00 g, 16.39 mmol), 4-methylmorpholine (1.66 g, 16.39 mmol), isobutylchloroformate (2.24 g, 16.39 mmol), and 4-aminomethylpyridine (1.77 g, 16.39 mmol) in the mixed carbonic anhydride method, gave 3.40 g (76%) of 8: mp 168°–170° C. (recrystallized from EtOAc);  $R_f$  0.31 (8% MeOH/CHCl<sub>3</sub>); IR (KBr) 3180, 1650 (br), 1480, 1400, 1340, 780, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, C(O)CH<sub>3</sub>), 4.32 (d, J=5.7 Hz, CH<sub>2</sub>), 5.57 (d, J=7.8 Hz, CH), 6.32–6.34 (m, C<sub>3</sub>H), 6.42–6.43 (m, C<sub>4</sub>H), 7.19 (d, J=4.9 Hz, C<sub>3</sub>H, C<sub>5</sub>H), 7.64 (s, C<sub>5</sub>H), 8.46 (d, J=4.9 Hz, C<sub>2</sub>H, C<sub>6</sub>H), 8.64 (d, J=7.8 Hz, NH), 8.84 (t, J=5.7 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.27 (C(O)CH<sub>3</sub>), 41.26 (CH<sub>2</sub>), 50.99 (CH), 107.74 (C<sub>4</sub>), 110.54 (C<sub>3</sub>), 121.87 (C<sub>3</sub>', C<sub>5</sub>'), 142.63 (C<sub>5</sub>), 148.17 (C<sub>4</sub>'), 149.35 (C<sub>2</sub>', C<sub>6</sub>'), 150.82 (C<sub>2</sub>), 168.35 (C(O)NH), 169.29 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 274 (M<sup>+</sup>+1). Anal. (C<sub>14</sub>H<sub>15</sub>N<sub>3</sub>O<sub>3</sub>) C, H, N.

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## EXAMPLE 91

Synthesis of  $\alpha$ -Acetamido-N-(1-oxo-3-pyridinylmethyl)-2-furanacetamide (9).

A solution of 7 (1.50 g, 5.49 mmol) and m-chloroperoxybenzoic acid (1.90 g, 6.04 mmol) in THF (175 mL) was heated to reflux (3 h) and then cooled to room temperature. The THF solution was concentrated to approximately half its volume, and then cooled to give 1.00 g (63%) of 9: mp 159°–161° C. (recrystallized from EtOH);  $R_f$  0.30 (20% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 1620, 1500 (br), 1420, 1350, 750 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.27 (d, J=5.0 Hz, CH<sub>2</sub>) 5.53 (d, J=7.6 Hz, CH), 6.31 (br s, C<sub>3</sub>H), 6.42 (br s, C<sub>4</sub>H), 7.14–7.18 (m, 1 ArH), 7.34–7.37 (m, 1 ArH), 7.61 (br s, C<sub>5</sub>H), 8.07 (s, 2 ArH), 8.63 (br s, NH), 8.80 (br s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.29 (C(O)CH<sub>3</sub>), 39.36 (CH<sub>2</sub>), 50.99 (CH), 107.79 (C<sub>4</sub>), 110.56 (C<sub>3</sub>), 124.03 (C<sub>4</sub>'), 126.10 (C<sub>5</sub>'), 137.16 (C<sub>3</sub>'), 137.31 (C<sub>6</sub>'), 138.70 (C<sub>2</sub>'), 142.69 (C<sub>5</sub>'), 150.72 (C<sub>2</sub>), 168.40 (C(O)NH), 169.32 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 289 (M<sup>+</sup>);  $M_r$  (EI) 289.10554 (calcd for C<sub>14</sub>H<sub>15</sub>N<sub>3</sub>O<sub>4</sub>, 289.10626).

Anal. Calcd for C<sub>14</sub>H<sub>15</sub>N<sub>3</sub>O<sub>4</sub>·2.0 H<sub>2</sub>O: C, 51.69; H, 5.89; N, 12.92. Found: C, 52.03; H, 5.56; N, 13.36.

## EXAMPLE 92

Synthesis of  $\alpha$ -Acetamido-N-(1-oxo-4-pyridinylmethyl)-2-furanacetamide (10).

Following the preceding procedure and using 8 (1.50 g, 5.49 mmol) and m-chloroperoxybenzoic acid (1.90 g, 6.04 mmol) gave a light yellow solid (0.96 g, 60%) directly upon cooling the THF solution. The precipitate was filtered and recrystallized from EtOH to give 10: mp 210°–212° C. (d);  $R_f$  0.25 (20% MeOH/CHCl<sub>3</sub>); IR (KBr) 3300, 1620, 1500, 1410, 1350, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.26 (d, J=5.8 Hz, CH<sub>2</sub>), 5.52 (d, J=7.7 Hz, CH), 6.30 (br s, C<sub>3</sub>H), 6.41–6.42 (m, C<sub>4</sub>H), 7.21 (d, J=6.8 Hz, C<sub>3</sub>H, C<sub>5</sub>H), 7.63 (s, C<sub>5</sub>H), 8.14 (d, J=6.8 Hz, C<sub>2</sub>H, C<sub>6</sub>H), 8.62 (d, J=7.7 Hz, NH), 8.82 (t, J=5.8 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.35 (C(O)CH<sub>3</sub>), 40.68 (CH<sub>2</sub>), 51.14 (CH), 107.87 (C<sub>4</sub>), 110.62 (C<sub>3</sub>), 124.83 (C<sub>3</sub>', C<sub>5</sub>'), 137.43 (C<sub>4</sub>'), 138.39 (C<sub>2</sub>', C<sub>6</sub>'), 142.72 (C<sub>5</sub>'), 150.77 (C<sub>2</sub>), 168.48 (C(O)NH), 169.45 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 289 (M<sup>+</sup>). Anal. (C<sub>14</sub>H<sub>15</sub>N<sub>3</sub>O<sub>4</sub>) C, H, N.

## EXAMPLE 93

Synthesis of  $\alpha$ -Acetamido-2-furanacetic-2'-pyridinehydrazide (11).

Following the mixed carbonic anhydride procedure and using racemic 19 (2.00 g, 10.39 mmol), 4-methylmorpholine (1.10 g, 10.93 mmol), isobutylchloroformate (1.49 g, 10.93 mmol), and 2-hydrazinopyridine (1.20 g, 11.00 mmol) gave an insoluble material upon workup containing 11 and 4-methylmorpholine hydrochloride. The reaction products were suspended in EtOH (25 mL), and 11 (1.00 g) was collected by filtration. Concentration of the THF filtrate and trituration of the residue with EtOAc gave an additional 0.70 g of 11 to give a combined yield of 1.70 g (64%): mp

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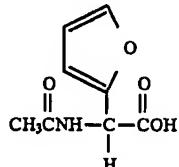
64

226°–228° C. (recrystallized from EtOH);  $R_f$  0.30 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 1650, 1580, 1440, 1360, 1320, 770, 730 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.83 (s, C(O)CH<sub>3</sub>), 5.64 (d, J=8.0 Hz, CH), 6.41–6.50 (m, C<sub>3</sub>H, C<sub>4</sub>H, C<sub>5</sub>H), 6.67 (dd, J=5.4, 6.7 Hz, C<sub>3</sub>H), 7.44–7.52 (m, C<sub>4</sub>H), 7.66 (s, C<sub>5</sub>H), 8.02 (d, J=4.0 Hz, C<sub>6</sub>H), 8.40 (s, C(O)NHNH), 8.66 (d, J=8.0 Hz, NH), 10.20 (s, C(O)NHNH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.26 (C(O)CH<sub>3</sub>), 49.56 (CH), 105.93 (C<sub>3</sub>'), 107.87 (C<sub>3</sub>), 110.57 (C<sub>4</sub>), 114.50 (C<sub>5</sub>'), 137.48 (C<sub>4</sub>'), 142.76 (C<sub>5</sub>), 147.45 (C<sub>6</sub>'), 150.60 (C<sub>2</sub>), 159.59 (C<sub>2</sub>'), 167.88 (C(O)NH), 169.28 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 274 (M<sup>+</sup>);  $M_r$  (EI) 274.10649 (calcd for C<sub>13</sub>H<sub>14</sub>N<sub>4</sub>O<sub>3</sub>, 274.10659).

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## EXAMPLE 94

Synthesis of R(-)  $\alpha$ -Acetamido-N-(4-fluorobenzyl)-2-furanacetamide ((R)-12).

Using (R)-19 (0.94 g, 5.1 mmol), 4-methylmorpholine (0.52 g, 5.1 mmol), isobutylchloroformate (0.70 g, 5.1 mmol), and 4-fluorobenzylamine (0.65 g, 5.16 mmol) in the mixed carbonic anhydride method gave 1.00 g (68%) of (R)-12: mp 205°–207° C. (recrystallized from EtOAc);  $R_f$  0.30 (4% MeOH/CHCl<sub>3</sub>);  $[\alpha]^{26}_D$  = -77.42 (c=1, MeOH); IR (KBr) 3400 (br), 1620, 1580, 1500 (br), 1350, 770, 720 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.27 (d, J=5.9 Hz, CH<sub>2</sub>), 5.54 (d, J=8.0 Hz, CH), 6.27 (d, J=3.0 Hz, C<sub>3</sub>H), 6.41 (dd, J=1.9, 3.0 Hz, C<sub>4</sub>H), 7.08–7.15 (m, 2 ArH), 7.20–7.26 (m, 2 ArH), 7.61 (d, J=1.9 Hz, C<sub>5</sub>H), 8.58 (d, J=8.0 Hz, NH), 8.74 (t, J=5.9 Hz, NH) ppm; addition of R(-) mandelic acid to a CDCl<sub>3</sub> solution of (R)-12 gave only one signal for the acetamide methyl protons. Mass spectrum (FD) 290 (M<sup>+</sup>) Anal. (C<sub>15</sub>H<sub>15</sub>FN<sub>2</sub>O<sub>3</sub>) C, H, N.

Synthesis of R(-) $\alpha$ -Acetamido-N-(4-methylbenzyl)-2-furanacetamide ((R)-13).

Employing the mixed carbonic anhydride procedure and making use of (R)-19 (1.50 g, 8.20 mmol), 4-methylmorpholine (0.83 g, 8.20 mmol), isobutylchloroformate (1.12 g, 8.20 mmol), and 4-methylbenzylamine (0.99 g, 8.20 mmol) gave 1.80 g (77%) of (R)-13: mp 210–212° C. (recrystallized from EtOAc);  $R_f$  0.54 (4% MeOH/CHCl<sub>3</sub>);  $[\alpha]^{26}_D$  = -74.43 (c=1, MeOH); IR (KBr) 3400 (br), 1610 (br), 1500 (br), 1350, 1320, 780, 720 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 2.25 (s, CH<sub>3</sub>), 4.24 (d, J=5.5 Hz, CH<sub>2</sub>), 5.56 (d, J=8.1 Hz, CH), 6.28 (br s, C<sub>3</sub>H), 6.41 (br s, C<sub>4</sub>H), 7.09 (br s, 4ArH), 7.61 (br s, C<sub>5</sub>H), 8.58 (d, J=8.1 Hz, NH), 8.72 (t, J=5.5 Hz, NH) addition of (R)-(-)mandelic acid to a CDCl<sub>3</sub> solution of (R)-13 gave only one signal for the acetamide methyl protons. <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 20.64 (CH<sub>3</sub>), 22.32 (C(O)CH<sub>3</sub>), 42.00 (CH<sub>2</sub>), 50.88 (CH), 107.52 (C<sub>4</sub>), 110.50 (C<sub>3</sub>), 127.06 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.77 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 135.82 (C<sub>1</sub>' or C<sub>4</sub>'), 135.98 (C<sub>1</sub>' or C<sub>4</sub>'), 142.51 (C<sub>5</sub>), 151.21 (C<sub>2</sub>) 167.87 (C(O)NH), 169.17 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 287 (M<sup>+</sup>+1). Anal. (C<sub>16</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>) C, H, N.

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## EXAMPLE 95

Synthesis of R(-) $\alpha$ -Acetamido-N-(4-trifluoromethylbenzyl)-2-furanacetamide ((R)-14).

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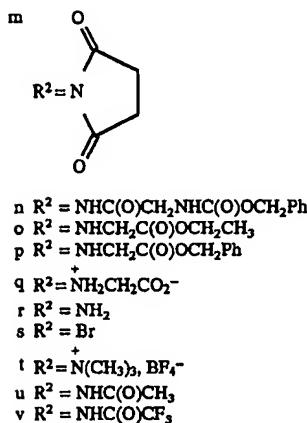
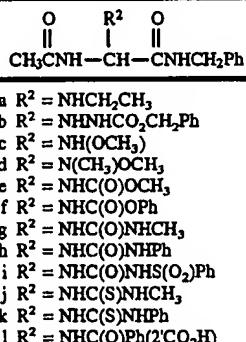
65

Using (R)-19 (1.00 g, 5.46 mmol), 4-methylmorpholine (0.55 g, 5.46 mmol), isobutylchloroformate (0.75 g, 5.46 mmol), and 4-trifluoromethylbenzylamine (0.96 g, 5.46 mmol) in the mixed carbonic anhydride protocol gave 1.15 g (59%) of (R)-14: mp 193°–195° C. (recrystallized from EtOAc/hexane);  $[\alpha]^{25}_{D} = -69.27$  (c=1, MeOH); IR (KBr) 3220, 1610, 1520, 1400, 1350, 800, 720  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.37 (d, J=5.8 Hz, CH<sub>2</sub>), 5.56 (d, J=7.9 Hz, CH), 6.30–6.31 (m, C<sub>3</sub>H), 6.41–6.43 (m, C<sub>4</sub>H), 7.40–7.43 (m, 2ArH), 7.63–7.68 (m, 2ArH, C<sub>5</sub>H), 8.62 (d, J=7.9 Hz, NH), 8.44 (t, J=5.8 Hz, NH); addition of (R)(–)-mandelic acid to a CDCl<sub>3</sub> solution of (R)-14 gave only one signal for the acetamide methyl protons. Mass spectrum (FD) 340 (M<sup>+</sup>). Anal. (C<sub>16</sub>H<sub>15</sub>F<sub>3</sub>N<sub>2</sub>O<sub>3</sub>) C, H, N.

#### GENERAL SYNTHESIS

**General Synthesis**—Several preparative routes were utilized for the construction of the targeted compounds. In most cases, 2-acetamido-N-benzyl-2-aminoacetamide (2r) served as the starting material. Treatment of 2r with the appropriate chloroformate, isocyanate, isothiocyanate, arthydride, or use of the mixed anhydride protocol advanced for peptide synthesis led to the preparation of the N-acyl substituted adducts 2e–2l and 2n. Correspondingly, the preformed  $\alpha$ -bromo derivative 2s was employed as the immediate precursor for 2m and 2p, while 2-acetamido-N-benzyl-2-(trimethylammonio)acetamide tetrafluoroborate (2t) was utilized for the synthesis of 2o. Finally, alkaline hydrolysis of 2p, followed by neutralization of the dipeptide by passage through an ion exchange resin yielded 2g.

In Examples 96–108, reference is made to the following compounds



#### EXAMPLE 96

**Chemistry—Synthesis of Methyl[acetamido(benzylcarbamoyl)methyl]carbamate (2e).**

Methyl chloroformate (0.33 g, 3.35 mmol) was added to a solution 2r (0.70 g, 3.16 mmol) and Et<sub>3</sub>N (0.39 g, 3.80 mmol) in THF (75 mL), and then the reaction mixture was stirred at 55°–60° C. (2 h). The Et<sub>3</sub>N.HCl that precipitated was filtered and the filtrate was concentrated to dryness in vacuo. The residue was triturated with EtOAc (20 mL), and the remaining white solid (0.55 g, 62%) was filtered and recrystallized from EtOH: mp. 202°–204° C. (d); R<sub>f</sub> 0.53 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3260, 1650, 1500, 1440, 1360, 780, 690  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.86 (s, C(O)CH<sub>3</sub>), 3.54 (s, OCH<sub>3</sub>), 4.27 (d, J=5.6 Hz, CH<sub>2</sub>), 5.56 (t, J=7.8 Hz, CH), 7.18–7.32 (m, 5PhH), 7.70 (br s, NHC(O)OCH<sub>3</sub>), 8.40 (d, J=7.8 Hz, NH), 8.51 (t, J=5.6 Hz, NH);  $^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.38 (C(O)CH<sub>3</sub>), 42.29 (CH<sub>2</sub>), 51.46 (OCH<sub>3</sub>), 58.57 (CH), 126.52 (C<sub>4</sub>'), 126.98 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 127.99 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 139.03 (C<sub>1</sub>'), 167.83 (C(O)NH), 169.33 (C(O)CH<sub>3</sub>) ppm, the carbamate carbonyl signal was not detected. Mass spectrum (FD) 279 (M<sup>+</sup>).

Anal. Calcd for C<sub>13</sub>H<sub>17</sub>N<sub>3</sub>O<sub>4</sub>: C, 55.91; H, 6.14; N, 15.05. Found: C, 56.16; H, 6.10; N, 14.89.

#### EXAMPLE 97

**Synthesis of Phenyl[acetamido(benzylcarbamoyl)methyl]carbamate (2f).**

Compound 2r (0.80 g, 3.62 mmol) was dissolved in warm THF (75 mL), and then Et<sub>3</sub>N (0.44 g, 4.35 mmol), and phenyl chloroformate (0.62 g, 3.98 mmol) were added. The reaction mixture was stirred at 45°–50° C. (2 h), and the volatile materials were removed in vacuo. The residue was triturated with EtOAc (20 mL) and the remaining white solid material (0.80 g, 65%) was filtered, washed with H<sub>2</sub>O (10 mL), and then recrystallized from MeOH: mp 201°–203° C.; R<sub>f</sub> 0.38 (5% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 3240, 1700, 1630, 1500, 1460, 1320, 1200, 740, 600  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.29–4.35 (m, CH<sub>2</sub>), 5.66 (t, J=7.6 Hz, CH), 7.08–7.42 (m, 10ArH), 8.43 (d, J=7.6 Hz, NH), 8.58 (d, J=7.6 Hz, NH), 8.67 (t, J=5.0 Hz, NH);  $^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.58 (C(O)CH<sub>3</sub>), 42.51 (CH<sub>2</sub>), 58.69 (CH), 121.70 (2C<sub>2</sub>), 125.18 (C<sub>4</sub>), 126.76 (C<sub>4</sub>'), 127.19 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.21 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 129.30 (2C<sub>3</sub>'), 139.14 (C<sub>1</sub>'), 150.91 (C<sub>1</sub>'), 167.73 (C(O)NH), 169.75 (C(O)CH<sub>3</sub>) ppm, the signal for the carbamate carbonyl was not detected. Mass spectrum (FD) 341 (M<sup>+</sup>).

Anal. Calcd for C<sub>18</sub>H<sub>19</sub>N<sub>3</sub>O<sub>4</sub>: C, 63.33; H, 5.61; N, 12.31. Found: C, 63.06; H, 5.64; N, 12.12.

#### EXAMPLE 98

**Synthesis of 1-[Acetamido(benzylcarbamoyl)methyl]-3-methylurea (2g).**

Methyl isocyanate (0.20 g, 3.48 mmol) was added to a solution of 2r (0.70 g, 3.16 mmol) in THF (75 mL), and then the reaction was stirred at 45°–50° C. (2 h). The white solid (0.80 g, 91%) that separated out was filtered and recrystallized from MeOH to give 2g: mp 229°–230° C. (d); R<sub>f</sub> 0.25 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3200, 3060, 1630, 1500 (br), 1350, 1300, 740, 680  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.82 (s, C(O)CH<sub>3</sub>), 2.54 (d, J=4.5 Hz, NHCH<sub>3</sub>), 4.26 (d, J=5.8 Hz, CH<sub>2</sub>), 5.59 (t, J=7.8 Hz, CH), 6.19 (d, J=4.5 Hz, NHCH<sub>3</sub>), 6.52 (d, J=7.8 Hz, NHC(O)NHCH<sub>3</sub>), 7.20–7.31 (m, 5PhH), 8.38 (t, J=5.8 Hz, NH), 8.46 (d, J=7.8 Hz, NH);  $^{13}\text{C}$  NMR (DMSO-d<sub>6</sub>) 22.36 (C(O)CH<sub>3</sub>), 26.03 (NHCH<sub>3</sub>), 42.19 (CH<sub>2</sub>), 57.92 (CH), 126.54 (C<sub>4</sub>'), 126.93 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.06 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 139.16 (C<sub>1</sub>'), 157.30 (NHC(O)NH), 168.89 (C(O)NH), 169.37 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 279 (M<sup>+</sup>+1).

Anal. Calcd for C<sub>13</sub>H<sub>18</sub>N<sub>4</sub>O<sub>3</sub>: C, 56.10; H, 6.52; N, 20.13. Found: C, 56.31; H, 6.41; N, 20.12.

## EXAMPLE 99

Synthesis of 1-[Acetamido(benzylcarbamoyl)methyl]-3-phenylurea (2h).

Phenyl isocyanate (0.42 g, 3.5 mmol) was added to a solution of 2r (0.70 g, 3.16 mmol) in THF (75 mL), and then the reaction was stirred at 45°–50° C. (2 h). The white solid (0.95 g, 89%) that precipitated was filtered and dried: mp 242°≥244° C. (d);  $R_f$  0.30 (5% MeOH/CHCl<sub>3</sub>); IR (KBr) 3200 (br), 1600 (br), 1430 (br), 1300, 880, 700 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.86 (s, C(O)CH<sub>3</sub>), 4.30 (d, J=5.9 Hz, CH<sub>2</sub>), 5.67 (t, J=7.6 Hz, CH), 6.86–6.93 (m, 2ArH), 7.20–7.32 (m, NH, 5PhH, 1ArH), 7.37–7.40 (m, 2ArH), 8.56 (t, J=5.9 Hz, NH), 8.68 (d, J=7.6 Hz, NH), 8.89 (s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.38 (C(O)CH<sub>3</sub>), 42.29 (CH<sub>2</sub>), 57.59 (CH), 117.61 (2C<sub>2</sub>), 121.37 (C<sub>4</sub>), 126.57 (C<sub>4</sub>), 126.95 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.07 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.62 (2C<sub>3</sub>), 139.12 (C<sub>1</sub> or C<sub>1</sub>), 139.98 (C<sub>1</sub> or C<sub>1</sub>), 153.98 (NHC(O)NH), 168.55 (C(O)NH), 169.58 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 340 (M<sup>+</sup>).

Anal. Calcd for C<sub>18</sub>H<sub>20</sub>N<sub>4</sub>O<sub>3</sub>: C, 63.52; H, 5.92; N, 16.46. Found: C, 63.72; H, 5.92; N, 16.20.

## EXAMPLE 100

Synthesis of 1-[Acetamido(benzylcarbamoyl)methyl]-3-benzenesulfonylurea (2i).

Benzenesulfonyl isocyanate (0.64 g, 3.48 mmol) was added to a solution of 2r (0.70 g, 3.16 mmol) in THF (75 mL), and then the reaction was stirred at 50°–55° C. (22 h). The white solid (0.84 g, 66%) that separated on cooling was filtered and dried: mp 188°–191° C. (d);  $R_f$  0.11 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3250, 1630 (br), 1500 (br), 1460, 1330, 870, 700 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.80 (s, C(O)CH<sub>3</sub>), 4.24 (d, J=5.7 Hz, CH<sub>2</sub>), 5.47 (t, J=7.7 Hz, CH), 7.18–7.30 (m, 5PhH, NH), 7.57–7.71 (m, 3ArH), 7.89–7.92 (d, J=7.5 Hz, 2ArH), 8.54 (t, J=5.7 Hz, NH), 8.70 (d, J=7.7 Hz, NH), 10.80 (s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.29 (C(O)CH<sub>3</sub>), 42.30 (CH<sub>2</sub>), 57.14 (CH), 126.58 (C<sub>4</sub>), 126.89 (2C<sub>2</sub>), 127.12 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.05 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.96 (2C<sub>3</sub>), 133.25 (C<sub>4</sub>), 138.88 (C<sub>1</sub> or C<sub>1</sub>), 139.87 (C<sub>1</sub> or C<sub>1</sub>), 150.36 (NHC(O)NH), 167.55 (C(O)NH), 169.55 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 405 (M<sup>++1</sup>).

Anal. Calcd for C<sub>18</sub>H<sub>20</sub>N<sub>4</sub>O<sub>5</sub>S: C, 53.46; H, 4.98; N, 13.85. Found: C, 53.23; H, 5.04; N, 13.62.

## EXAMPLE 101

Synthesis of 1-[Acetamido(benzylcarbamoyl)methyl]-3-methylthiourea (2j).

A solution of 2r (0.50 g, 2.26 mmol) and methyl isothiocyanate (0.20 g, 2.27 mmol) in THF (75 mL) was heated to reflux (4 h), and then the volatile materials were removed in vacuo. The residue was recrystallized from absolute EtOH to give 2j as a white solid (0.22 g, 33%): mp 162°–163° C. (d);  $R_f$  0.45 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 3220 (br), 1620, 1500, 1430, 1340, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.83 (s, C(O)CH<sub>3</sub>), 2.85 (br s, NHCH<sub>3</sub>), 4.27 (d, J=5.8 Hz, CH<sub>2</sub>), 6.10 (br s, CH), 7.17–7.30 (m, 5PhH), 7.80 (br s, NH), 7.96 (br s, NH), 8.44 (br s, NH), 8.72 (s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.39 (C(O)CH<sub>3</sub>), 30.92 (NHCH<sub>3</sub>), 42.45 (CH<sub>2</sub>), 61.33 (CH), 126.68 (C<sub>4</sub>), 127.06 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.16 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.15 (C<sub>1</sub>), 168.17 (C(O)NH), 170.30 (C(O)CH<sub>3</sub>) ppm, the signal for the thiocarbonyl carbon group was not detected. Mass spectrum (FD) 294 (M<sup>+</sup>).

Anal. Calcd for C<sub>13</sub>H<sub>18</sub>N<sub>4</sub>O<sub>2</sub>S: C, 53.04; H, 6.16; N, 19.03. Found: C, 53.16; H, 6.31; N, 18.89.

## EXAMPLE 102

Synthesis of 1-[Acetamido(benzylcarbamoyl)methyl]-3-phenylthiourea (2k).

5 A solution of 2r (0.70 g, 3.16 mmol) and phenyl isothiocyanate (0.47 g, 3.48 mmol) in THF (75 mL) was heated to reflux (3 h), and then the volatile materials were removed in vacuo. The residue was triturated with EtOH (15 mL), and the white solid material (0.70 g, 62%) that remained was 10 filtered and recrystallized from absolute EtOH: mp 196°–197° C. (d);  $R_f$  0.65 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 3240 (br), 1620, 1470 (br), 1330, 750, 670 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.89 (s, C(O)CH<sub>3</sub>), 4.32 (d, J=5.8 Hz, CH<sub>2</sub>), 5.24 (t, J=6.9 Hz, CH), 7.09–7.43 (m, 3ArH, 15 5PhH), 7.52–7.55 (m, 2ArH), 8.13 (d, J=6.9 Hz, NH), 8.55 (br s, NH), 8.85 (br s, NH), 10.11 (s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.22 (C(O)CH<sub>3</sub>), 42.36 (CH<sub>2</sub>), 61.18 (CH), 122.76 (2C<sub>2</sub>), 124.29 (C<sub>4</sub>), 126.53 (C<sub>4</sub>), 126.90 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.00 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.40 (2C<sub>3</sub>), 138.94 (C<sub>1</sub> or C<sub>1</sub>), 139.01 (C<sub>1</sub> or C<sub>1</sub>), 167.82 (C(O)NH), 169.98 (C(O)CH<sub>3</sub>), 180.02 (C(S)) ppm; mass spectrum (FD) 356 (M<sup>+</sup>).

Anal. Calcd for C<sub>18</sub>H<sub>20</sub>N<sub>4</sub>O<sub>2</sub>S: C, 60.65; H, 5.66; N, 15.72. Found: C, 60.43; H, 5.70; N, 15.62.

## EXAMPLE 103

Synthesis of N-[Acetamido(benzylcarbamoyl)methyl]phthalamic acid (2l).

To a warm pyridine solution (7.0 mL) containing 2r (0.63 g, 2.83 mmol), phthalic anhydride (0.43 g, 2.87 mmol) was 30 added, and the reaction was stirred at 50°–55° C. (5 h). Pyridine was removed by distillation in vacuo and the residue was treated with H<sub>2</sub>O (20 mL). The aqueous mixture was extracted with EtOAc (2×20 mL) and then acidified with aqueous 1N HCl solution. The white solid (0.70 g, 70%) that precipitated was filtered, washed with H<sub>2</sub>O (10 mL), and dried: mp 186°–188° C.; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, C(O)CH<sub>3</sub>), 4.36 (d, J=6.0 Hz, CH<sub>2</sub>), 5.92 (t, J=7.2 Hz, CH), 7.20–7.31 (m, 5PhH), 7.43 (d, J=7.3 Hz, C<sub>6</sub>H), 7.50–7.63 (m, C<sub>4</sub>H, C<sub>5</sub>H), 7.82 (d, J=7.3 Hz, C<sub>3</sub>H), 8.41–8.48 (m, 2NH), 9.01 (d, J=7.2 Hz, NH), 13.30 (br s, CO<sub>2</sub>H); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.46 (C(O)CH<sub>3</sub>), 42.39 (CH<sub>2</sub>), 57.44 (CH), 126.57, 126.92, 127.81, 128.09, 128.72, 129.36, 129.85, 131.49, 137.78, 138.99 (ARC, PhC), 40 167.85, 167.93, 168.48, 169.47 (C(O)) ppm; mass spectrum (FD) 370 (M<sup>++1</sup>).

Anal. Calcd for C<sub>19</sub>H<sub>15</sub>N<sub>3</sub>O<sub>5</sub>: C, 61.78; H, 5.18; N, 11.38. Found: C, 61.63; H, 5.05; N, 11.16.

## EXAMPLE 104

Synthesis of 2-Acetamido-N-benzyl-2-(N-succinimidyl)acetamide (2m).

A cooled (–78° C.) THF solution (150 mL) of 2s<sup>2</sup> (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide<sup>4,5</sup> (2.00 g, 8.0 mmol) and BBr<sub>3</sub> (2.51 g, 10.05 mmol)) was added slowly into a cooled (–78° C.) THF suspension (50 mL) of sodium succinimide (3.06 g, 25.25 mmol). The reaction mixture was stirred at –78° C. (30 min) and at room temperature (90 min), and then treated with a 55 10% aqueous citric acid solution (50 mL). The resulting solution was neutralized with a saturated aqueous NaHCO<sub>3</sub> solution, and the reaction mixture extracted with EtOAc (3×100 mL). The combined extracts were dried (Na<sub>2</sub>SO<sub>4</sub>), and the volatile materials were removed by distillation in vacuo. The residue was purified by flash column chromatography on SiO<sub>2</sub> gel (6% MeOH/CHCl<sub>3</sub>) to give 1.10 g (45%) of 2m: mp 1.80°–183° C. (recrystallized from EtOH); 60 65

$R_f$  0.26 (6% MeOH/CHCl<sub>3</sub>); IR (KBr) 3340 (br), 1620 (br), 1480 (br), 1340, 780, 670 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, C(O)CH<sub>3</sub>), 2.67 (s, CH<sub>2</sub>CH<sub>2</sub>), 4.23–4.36 (m, CH<sub>2</sub>), 6.31 (d, J=9.0 Hz, CH), 7.17–7.35 (m, 5 PhH), 8.63 (t, J=5.9 Hz, NH), 8.72 (d, J=9.0 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.36 (C(O)CH<sub>3</sub>), 27.99 (s, CH<sub>2</sub>CH<sub>2</sub>), 42.59 (CH<sub>2</sub>), 55.19 (CH), 126.63 (C<sub>4</sub>'), 126.96 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.08 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 138.91 (C<sub>1</sub>'), 165.41 (C(O)NH), 169.86 (C(O)CH<sub>3</sub>), 176.5 (C(O)CH<sub>2</sub>CH<sub>2</sub>C(O)) ppm; mass spectrum (FAB) 304 (M<sup>+</sup>), 1, 17), 163 (12), 155 (48), 152 (51), 135 (68), 119 (100).

Anal. Calcd for C<sub>15</sub>H<sub>17</sub>N<sub>3</sub>O<sub>4</sub>: C, 59.40; H, 5.65; N, 13.85. Found: C, 59.63; H, 5.70; N, 13.66.

#### EXAMPLE 105

##### Synthesis of Benzyl N-[Acetamido(benzylcarbamoyl)methyl]malonamate (2n).

4-Methylmorpholine (0.35 g, 3.56 mmol) was added to a solution of N-CBZ-glycine (0.74 g, 3.55 mmol) in THF (75 mL) at -10° to -15° C. The solution was stirred (5 min), and then isobutyl chloroformate (0.49 g, 3.55 mmol) was added and the mixture was stirred for an additional 20 min. A cooled (-10° C.) solution of 2r (0.79 g, 3.55 mmol) in THF (125 mL) was then added slowly (30 min). The reaction mixture was stirred at this temperature (2 h) and then at room temperature (2 h). The insoluble materials were filtered and the filtrate was concentrated in vacuo. The residue was triturated with EtOAc (20 mL) and the white solid (0.60 g) that remained was filtered, washed with H<sub>2</sub>O and dried to give 2n. The initial insoluble material on trituration with H<sub>2</sub>O gave an additional 0.40 g of 2n to give a combined yield of 1.00 g (68%); mp 177°–179° C. (recrystallized from EtOH); R<sub>f</sub> 0.46 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 3260, 1640 (br), 1540 (br), 1480, 1450, 1370, 760, 690 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.86 (s, C(O)CH<sub>3</sub>), 3.60–3.77 (m, C(O)CH<sub>2</sub>NH), 4.28 (d, J=5.8 Hz, CH<sub>2</sub>), 5.01 (s, OCH<sub>2</sub>Ph), 5.79 (t, J=7.7 Hz, CH), 7.18–7.34 (m, 5 PhH, 5 ArH), 7.49 (t, J=5.8 Hz, NH), 8.43–8.55 (m, 3xNH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.36 (C(O)CH<sub>3</sub>), 42.28 (CH<sub>2</sub>), 43.39 (C(O)CH<sub>2</sub>NH), 56.77 (CH), 65.42 (OCH<sub>2</sub>Ph), 126.55 (2C), 126.94 (2C), 127.54, 127.66, 128.04 (2C), 128.22 (2C), 136.89, 138.96 (ArC, PhC), 156.40 (NHC(O)OCH<sub>2</sub>Ph), 167.86 (NHC(O)CH<sub>2</sub>), 168.96 (C(O)NH), 169.30 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 413 (M<sup>+</sup>+1), 100), 278 (75).

Anal. Calcd for C<sub>21</sub>H<sub>24</sub>N<sub>4</sub>O<sub>5</sub>: Found: C, 60.90; C, 61.16; H, 5.87; N, 13.58; H, 5.77; N, 13.35.

#### EXAMPLE 106

##### Synthesis of Ethyl N-[Acetamido(benzylcarbamoyl)methyl]glycinate (2o).

A methanolic solution (70 mL) containing 2t (1.50 g, 4.28 mmol) and ethyl glycinate (prepared from ethyl glycinate hydrochloride (3.10 g, 22.2 mmol), NaOMe (1.17 g, 21.74 mmol)) was heated to reflux (2 h). The reaction was concentrated in vacuo to give an oily residue that was purified by flash column chromatography on SiO<sub>2</sub> gel (5% MeOH/CHCl<sub>3</sub>) to give 0.60 g (46%) of 29o: mp 125°–127° C. (recrystallized from EtOAc); R<sub>f</sub> 0.43 (5% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 3200, 1710, 1600, 1500, 1430, 1350, 740, 680 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.17 (t, J=7.1 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 1.86 (s, C(O)CH<sub>3</sub>), 2.65–2.74 (m, NHCH<sub>2</sub>C(O)), 3.26–3.33 (m, NHCH<sub>2</sub>C(O)), 4.07 (q, J=7.1 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 4.28 (d, J=5.8 Hz, CH<sub>2</sub>), 5.01 (t, J=8.2 Hz, CH), 7.19–7.35 (m, 5 PhH), 8.25 (d, J=8.2 Hz, NH), 8.58 (t, J=5.8 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 13.98 (OCH<sub>2</sub>CH<sub>3</sub>), 22.46 (C(O)CH<sub>3</sub>), 42.13 (CH<sub>2</sub>), 46.22 (NHCH<sub>2</sub>C(O)), 60.07 (OCH<sub>2</sub>CH<sub>3</sub>), 63.96 (CH), 126.67 (C<sub>4</sub>), 127.09 (2C<sub>2</sub> or

2C<sub>3</sub>), 128.13 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.07 (C<sub>1</sub>'), 169.07 (C(O)NH), 170.09 (C(O)CH<sub>3</sub>), 171.56 (C(O)OCH<sub>2</sub>CH<sub>3</sub>) ppm; mass spectrum (FD) 342 (M<sup>+</sup>).

Anal. Calcd for C<sub>15</sub>H<sub>21</sub>N<sub>3</sub>O<sub>4</sub>: C, 58.62; H, 6.89; N, 13.67. Found: C, 58.83; H, 7.00; N, 13.73.

#### EXAMPLE 107

##### Synthesis of Benzyl N-[Acetamido(benzylcarbamoyl)methyl]glycinate (2p).

10 A suspension of benzyl glycinate hydrochloride (5.00 g, 24.8 mmol) in THF (400 mL) containing Et<sub>3</sub>N (4.90 g, 48.5 mmol) was stirred (4 h) at room temperature. The reaction mixture was cooled (-78° C.) and then a cooled (-78° C.) THF solution (150 mL) of 2s (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (4.00 g, 16.0 mmol) and BBr<sub>3</sub> (1M in CH<sub>2</sub>Cl<sub>2</sub>, 20.0 mL, 20.0 mmol)) was added (30 min).

The reaction mixture was stirred at -78° C. (30 min) and then at room temperature (16 h). The insoluble materials were filtered, the filtrate concentrated in vacuo, and the residue was purified by flash column chromatography on SiO<sub>2</sub> gel (3% MeOH/CHCl<sub>3</sub>) to give 1.56 g (26%) of 2p as a white solid; mp 133°–135° C. (recrystallized from EtOH); R<sub>f</sub> 0.36 (3% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 3220, 1710, 1620, 1510, 1440, 1350, 740, 680 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, C(O)CH<sub>3</sub>), 2.71–2.82 (m, NHCH<sub>2</sub>C(O)), 3.39 (d, J=6.1 Hz, NHCHHC(O)), 3.40 (d, J=6.1 Hz, NHCHHC(O)), 4.27 (d, J=6.1 Hz, CH<sub>2</sub>), 5.02 (t, J=8.2 Hz, CH), 5.11 (s, OCH<sub>2</sub>Ph), 7.19–7.36 (m, 5 PhH, 5 ArH), 8.24 (d, J=8.2 Hz, NH), 8.57 (t, J=6.1 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.42 (C(O)CH<sub>3</sub>), 42.11 (CH<sub>2</sub>), 46.22 (NHCH<sub>2</sub>C(O)), 63.94 (CH), 65.53 (OCH<sub>2</sub>Ph), 126.62, 127.05 (2C), 127.80 (2C), 127.91, 128.08 (2C), 128.29 (2C), 135.87, 139.02 (ArC, PhC), 169.01 (C(O)NH), 170.06 (C(O)CH<sub>3</sub>), 171.45 (C(O)OCH<sub>2</sub>Ph) ppm; mass spectrum (FD) 370 (M<sup>+</sup>+1).

25 30 35 Anal. Calcd for C<sub>20</sub>H<sub>23</sub>N<sub>3</sub>O<sub>4</sub>: C, 65.03; H, 6.28; N, 11.37. Found: C, 65.15; H, 6.53; N, 11.31.

#### EXAMPLE 108

##### Synthesis of N-[Acetamido(benzylcarbamoyl)methyl]glycine (2g).

40 A solution of methyl N-[acetamido(benzylcarbamoyl)methyl]glycinate (0.60 g, 2.05 mmol) and KOH (0.30 g, 5.36 mmol) in 90% aqueous EtOH (50 mL) was stirred at room temperature (48 h). The volatile materials were then removed in vacuo, and the residue dissolved in H<sub>2</sub>O (10 mL).

45 The aqueous solution was extracted with EtOAc (2x20 mL), and the aqueous layer was acidified to pH -2.0 with aqueous 1N HCl. A column containing ion exchange resin 50 Dowex 50x W4 was prepared using 10% aqueous pyridine. The column was thoroughly washed with H<sub>2</sub>O. The acidic aqueous reaction solution was added to the top of the column, and the column was eluted with H<sub>2</sub>O (300 mL) or until the eluate was neutral. The column was then eluted with 10% aqueous pyridine (400 mL). The aqueous pyridine fraction was concentrated in vacuo to give a white solid, dried in vacuo, and then triturated with absolute EtOH (7 mL).

55 The insoluble materials that remained were filtered and dried to give 0.29 g (50%) of 2q: mp 124°–126° C. (d); IR (KBr) 3400, 3200, 1630, 1500, 1370, 690 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.84 (s, C(O)CH<sub>3</sub>), 3.26 (s, CH<sub>2</sub>C(O)), 4.29 (d, J=5.7 Hz, CH<sub>2</sub>), 4.98 (d, J=8.2 Hz, CH), 7.21–7.33 (m, NH, 5 PhH), 8.39 (d, J=8.2 Hz, NH), 8.47 (t, J=5.7 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.41 (C(O)CH<sub>3</sub>), 41.98 (CH<sub>2</sub>), 47.48 (CH<sub>2</sub>C(O)), 64.08 (CH), 126.75 (C<sub>4</sub>'), 127.21 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 128.24 (2C<sub>2</sub>' or 2C<sub>3</sub>'), 139.23 (C<sub>1</sub>'), 169.91 (C(O)NH), 170.02 (C(O)CH<sub>3</sub>), 170.20 (CH<sub>2</sub>C(O) ppm.

60 65

Anal. Calcd for  $C_{13}H_{17}N_3O_4$ : C, 55.91; H, 6.13; N, 15.04. Found: C, 55.68; H, 6.06; N, 14.74.

#### EXAMPLE 109

##### Synthesis of 2-Acetamido-N-benzyl-2-(1-pyrrole) acetamide.

A cooled ( $-78^\circ$  C.) THF solution (225 mL) of 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol) and  $BBBr_3$  (1M  $CH_2Cl_2$  solution, 8.8 mL, 8.8 mmol)) was added under  $N_2$  a cooled ( $-78^\circ$  C.) suspension of potassium pyrrole (2.71 g, 25.8 mmol) in THF (25 mL). The reaction mixture was stirred at  $-78^\circ$  C. (1 h) and then at room temperature (1 h), and then treated with  $H_2O$  (10 mL) and acidified ('pH' 4.0) with 5% citric acid. The reaction was made basic with aqueous saturated  $Na_2CO_3$  solution, and the aqueous mixture was extracted with  $EtOAc$  (2 $\times$ 250 mL) and the combined organic layers were dried ( $Na_2SO_4$ ). The volatile materials were removed in vacuo and the residue was purified by flash column chromatography on  $SiO_2$  gel using 3% MeOH/CHCl<sub>3</sub> as the eluent to give 0.40 g (18%) of the desired product. The compound X was purified by recrystallization from EtOH: mp 182°–184° C.;  $R_f$  0.44 (4% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 3280, 1630, 1520, 1370, 740, 720  $cm^{-1}$ ;  $^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.91 (s, C(O)CH<sub>3</sub>), 4.30 (d,  $J$ =5.5 Hz, CH<sub>2</sub>), 6.01 (s, 2 $\times$ C<sub>3</sub>H), 6.38 (d,  $J$ =8.7 Hz, CH), 6.85 (s, 2 $\times$ C<sub>2</sub>H), 7.11–7.35 (m, 5PhH), 8.96 (t,  $J$ =5.5 Hz, NH), 9.14 (d,  $J$ =8.7 Hz, NH);  $^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.22 (C(O)CH<sub>3</sub>), 42.15 (CH<sub>2</sub>), 62.86 (CH), 107.79 (2C<sub>3</sub>), 119.19 (2C<sub>2</sub>), 126.76 (C<sub>4</sub>), 127.01 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.11 (2C<sub>2</sub>, or 2C<sub>3</sub>), 138.34 (C<sub>1</sub>), 166.37 (C(O)NH), 169.41 (C(O)CH<sub>3</sub>) ppm; mass spectrum, m/e (relative intensity) 272 (M<sup>+</sup>+1, 22), 271 (M<sup>+</sup>, 100).

Anal. Calcd for  $C_{15}H_{17}N_3O_2$ : 0.2  $H_2O$ : C, 65.53; H, 6.37; N, 15.28. Found: C, 65.80; H, 6.22; N, 15.13.

#### EXAMPLE 110

##### Synthesis of 2-Acetamido-N-benzyl-2-(1-pyrazole) acetamide.

To a cooled ( $-78^\circ$  C.) solution (250 mL) of 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (3.60 g, 14.4 mmol) and  $BBBr_3$  (1M  $CH_2Cl_2$  solution, 15.8 mL, 15.8 mmol)), a THF solution (20 mL) of  $Et_3N$  (2.91 g, 28.8 mmol) was added, followed by the addition of THF solution (30 mL) of pyrazole (1.17 g, 17.28 mmol). The mixture was stirred at  $-78^\circ$  C. (30 min) and room temperature (1 h). The insoluble materials were filtered and the solvents removed in vacuo. The residue was purified by flash column chromatography on  $SiO_2$  gel using 4% MeOH/CHCl<sub>3</sub> as the eluent to give 0.80 g (22%) of the desired product. The compound X was recrystallized from  $EtOAc$  as a white solid: mp 158°–160° C.;  $R_f$  0.51 (6% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 3180, 1650, 1530, 1470, 1370, 1350, 740, 700  $cm^{-1}$ ;  $^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.93 (s, C(O)CH<sub>3</sub>), 4.29 (d,  $J$ =5.8 Hz, CH<sub>2</sub>), 6.26 (s, C<sub>4</sub>H), 6.57 (d,  $J$ =8.8 Hz, CH), 7.15–7.33 (m, 5PhH), 7.48 (br s, C<sub>5</sub>H), 7.76 (br s, C<sub>3</sub>H), 8.96 (t,  $J$ =5.8 Hz, NH), 9.23 (d,  $J$ =8.8 Hz, NH);  $^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.41 (C(O)CH<sub>3</sub>), 42.40 (CH<sub>2</sub>), 65.51 (CH), 105.37 (C<sub>4</sub>), 126.87 (C<sub>4</sub>), 127.14 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.25 (2C<sub>2</sub> or 2C<sub>3</sub>), 129.00 (C<sub>5</sub>), 138.59 (C<sub>3</sub>), 139.17 (C<sub>1</sub>), 165.68 (C(O)NH), 169.81 (C(O)CH<sub>3</sub>) ppm; mass spectrum, m/e (relative intensity) 273 (M<sup>+</sup>+1, 11), 272 (M<sup>+</sup>, 2), 139 (83), 138 (100), 92 (37).

Anal. Calcd for  $C_{14}H_{16}N_4O_2$ : C, 61.75; H, 5.92; N, 20.57. Found: C, 61.95; H, 5.96; N, 20.28.

#### EXAMPLE 111

##### Synthesis of 2-Acetamido-N-benzyl-2-(1-imidazole) acetamide.

Using the preceeding procedure, 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol),  $BBBr_3$  (1M  $CH_2Cl_2$  solution, 8.8 mL, 8.8 mmol),  $Et_3N$  (1.62 g, 1.60 mmol), and imidazole (0.60 g, 8.8 mmol) gave 0.60 g (30%) of the desired product. Compound X was recrystallized from ethyl acetate/hexane as a beige colored solid: mp 146°–148° C.;  $R_f$  0.7 (7% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400 (br), 1640, 1560, 1480, 1360, 720, 670  $cm^{-1}$ ;  $^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, C(O)CH<sub>3</sub>), 4.30 (br s, CH<sub>2</sub>), 6.53 (d,  $J$ =8.0 Hz, CH), 6.89 (s, C<sub>5</sub>H), 7.12–7.33 (m, C<sub>4</sub>H, 5PhH), 7.69 (s, C<sub>2</sub>H), 9.06 (br s, NH), 9.29 (d,  $J$ =8.0 Hz, NH);  $^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.28 (C(O)CH<sub>3</sub>), 42.36 (CH<sub>2</sub>), 61.18 (CH), 117.56 (C<sub>5</sub>), 126.92 (C<sub>4</sub>), 127.16 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.19 (C<sub>4</sub>), 128.26 (2C<sub>2</sub> or 2C<sub>3</sub>), 136.21 (C<sub>2</sub>), 138.27 (C<sub>1</sub>), 165.72 (C(O)NH), 169.77 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 274 (M<sup>+</sup>+2, 12), 273 (M<sup>+</sup>+1, 77), 272 (100), 205 (34) 274 (18).

Anal. Calcd for  $C_{14}H_{16}N_4O_2$ : C, 61.75; H, 5.92; N, 20.57. Found: C, 61.95; H, 6.09; N, 20.32.

#### EXAMPLE 112

##### Synthesis of 2-Acetamido-N-benzyl-2-(1-(1,2,4-triazole)) acetamide.

Using 2-acetamido-N-benzyl-2-ethoxyacetamide (4.00 g, 16.0 mmol),  $BBBr_3$  (1M  $CH_2Cl_2$  solution, 17.6 mL, 17.6 mmol),  $Et_3N$  (4.85 g, 48.0 mmol), and 1,2,4-triazole (1.43 g, 20.8 mmol), 1.20 g (28%) of the desired product was obtained. Compound X was recrystallized from  $EtOAc$  as an amorphous white solid: mp 146°–148° C.;  $R_f$  0.48 (6% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 1660, 1470, 1370, 830  $cm^{-1}$ ;  $^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.85 (s, C(O)CH<sub>3</sub>), 4.32 (br s, CH<sub>2</sub>), 6.70 (d,  $J$ =7.8 Hz, CH), 7.21–7.29 (m, 5PhH), 8.01 (s, C<sub>3</sub>H), 8.57 (s, C<sub>5</sub>H), 9.04 (br s, NH), 9.39 (d,  $J$ =7.8 Hz, NH);  $^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.39 (C(O)CH<sub>3</sub>), 42.59 (CH<sub>2</sub>), 65.02 (CH), 126.97 (C<sub>4</sub>), 127.25 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.32 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.47 (C<sub>1</sub>), 143.93 (C<sub>5</sub>), 151.50 (C<sub>3</sub>), 164.77 (C(O)NH), 170.23 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 274 (M<sup>+</sup>+1, 100), 273 (11), 205 (19), 204 (13), 140 (67), 139 (31).

Anal. Calcd for  $C_{13}H_{15}N_5O_2$ : C, 57.13; H, 5.53; N, 25.63. Found: C, 57.37; H, 5.66; N, 25.38.

#### EXAMPLE 113

##### Synthesis of 2-Acetamido-N-benzyl-2-(1-tetrazole)) acetamide.

Making use of 2-acetamido-N-benzyl-2-ethoxyacetamide (3.00 g, 12.0 mmol),  $BBBr_3$  (1M  $CH_2Cl_2$  solution, 13.2 mL, 13.2 mmol),  $Et_3N$  (2.42 g, 24.0 mmol), and tetrazole (1.10 g, 15.6 mmol), 0.90 g (27%) of the desired product was obtained as a white solid. The compound X was recrystallized from EtOH: mp 169°–171° C.;  $R_f$  0.22 (4% MeOH/CHCl<sub>3</sub>); IR (KBr) 3300 (br), 1660, 1510, 1360, 870, 740  $cm^{-1}$ ;  $^1H$  NMR (DMSO-d<sub>6</sub>)  $\delta$  1.97 (s, C(O)CH<sub>3</sub>), 4.25–4.40 (m, CH<sub>2</sub>), 7.05 (d,  $J$ =8.4 Hz, CH), 7.21–7.38 (m, 5PhH), 9.23 (t,  $J$ =5.5 Hz, NH), 9.44 (s, C<sub>5</sub>H), 9.69 (d,  $J$ =8.4 Hz, NH);  $^{13}C$  NMR (DMSO-d<sub>6</sub>) 22.38 (C(O)CH<sub>3</sub>), 42.78 (CH<sub>2</sub>), 63.62 (CH), 127.10 (C<sub>4</sub>), 127.39 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.38 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.26 (C<sub>1</sub>), 143.67 (C<sub>5</sub>), 163.88 (C(O)NH), 170.62 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 275 (M<sup>+</sup>, 79), 273 (14), 206 (100), 205 (50).

Anal. Calcd for  $C_{12}H_{14}N_6O_2$ : C, 52.55; H, 5.15; N, 30.64. Found: C, 52.75; H, 5.33; N, 30.64.

#### EXAMPLE 114

##### Synthesis of $\alpha$ -Acetamido-N-benzyl-1-(dimethylsulfamoyl) imidazole-4-acetamide.

To a cooled ( $-78^{\circ}$  C.) THF solution (150 mL) of 2-acetamido-N-benzyl-2-bromoacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol) and  $\text{BBr}_3$  (1M solution in  $\text{CH}_2\text{Cl}_2$ , 9.0 mL, 9.0 mmol)) was added  $\text{Et}_3\text{N}$  (1.62 g, 16.0 mmol), and then a THF solution of the 2-lithio salt of N,N-dimethylimidazole-1-sulfonamide (generated by the addition of n-BuLi (2.5M in hexane, 3.9 mL, 9.68 mmol) into a cooled ( $-78^{\circ}$  C.) THF solution (25 mL) of N,N-dimethylimidazole-1-sulfonamide (1.54 g, 8.8 mmol)) was added during a 15 min interval. The reaction mixture was stirred at this temperature (30 min) and then at room temperature (45 min). A saturated aqueous  $\text{NH}_4\text{Cl}$  solution (50 mL) and  $\text{H}_2\text{O}$  (50 mL) were then successively added to the reaction, and the aqueous mixture was extracted with  $\text{EtOAc}$  (3 $\times$ 50 mL). The combined extracts were dried ( $\text{Na}_2\text{SO}_4$ ), and the volatile materials were removed by distillation in vacuo. The residue was purified by flash column chromatography on  $\text{SiO}_2$  gel (4% MeOH/CHCl<sub>3</sub>) to give 0.50 g (17%) of the desired product: mp 145°–147° C. (recrystallized from EtOAc/hexane);  $R_f$  0.35 (4% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 1640, 1530, 1380, 720  $\text{cm}^{-1}$ ; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.96 (s, C(O)CH<sub>3</sub>), 2.77 (s, N(CH<sub>3</sub>)<sub>2</sub>), 4.25 (dd, J=6.0, 15.5 Hz, CHH), 4.34 (dd, J=6.0, 15.5 Hz, CHH), 5.43 (d, J=8.0, Hz, CH), 7.19–7.30 (m, 5 PhH), 7.40 (s, C<sub>5</sub>H), 8.17 (s, C<sub>2</sub>H), 8.42 (d, J=8.0 Hz, NH), 8.67 (t, J=6.0 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.42 (C(O)CH<sub>3</sub>), 37.80 (N(CH<sub>3</sub>)<sub>2</sub>), 42.11 (CH<sub>2</sub>), 51.40 (CH), 115.50 (C<sub>5</sub>), 126.64 (C<sub>4</sub>), 126.94 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.12 (2C<sub>2</sub> or 2C<sub>3</sub>), 136.70 (C<sub>2</sub>), 139.17 (C<sub>1</sub>), 140.26 (C<sub>4</sub>), 168.93 (C(O)NH), 169.09 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 380 (M<sup>+</sup>+1, 34), 248 (13), 247 (100), 108 (64).

Anal. Calcd for C<sub>16</sub>H<sub>21</sub>N<sub>5</sub>O<sub>4</sub>S: C, 50.65; H, 5.58; N, 17.87. Found: C, 51.92; H, 5.65; N, 18.09.

#### EXAMPLE 115

##### Synthesis of $\alpha$ -Acetamido-N-benzyl-4-imidazole acetamide.

A 75% aqueous EtOH (16 mL) solution of  $\alpha$ -acetamido-N-benzyl-1-(N,N-dimethylsulfamido)imidazole-4-acetamide (0.85 g, 3.05 mmol) was acidified ("pH" ~1.5) with ethanolic HCl, and the solution was heated to reflux (8 h). The reaction was neutralized with a saturated aqueous NaHCO<sub>3</sub> solution and the EtOH-H<sub>2</sub>O azeotrope removed by distillation in vacuo. The remaining aqueous layer was made basic ("pH" 10) with aqueous NaOH. The aqueous mixture was extracted with  $\text{EtOAc}$  (3 $\times$ 50 mL) and the combined extracts were dried ( $\text{Na}_2\text{SO}_4$ ). The reaction was concentrated in vacuo to give 0.35 g (57%) of the desired product: mp 189°–191° C. (d) (recrystallized from acetone);  $R_f$  0.19 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3400, 3260, 1650, 1600, 1500, 1430, 1360, 1330, 730, 710  $\text{cm}^{-1}$ ; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.88 (s, C(O)CH<sub>3</sub>), 4.28 (d, J=5.9 Hz, CH<sub>2</sub>), 5.38 (d, J=6.8 Hz, CH), 5.38 (br s, C<sub>5</sub>H), 7.15–7.30 (m, 5 PhH), 7.60 (s, C<sub>5</sub>H), 8.26 (br s, NH), 8.53 (br s, NH), 12.01 (br s, NH) ppm; mass spectrum (FD) 273 (M<sup>+</sup>+1).

Anal. Calcd for C<sub>14</sub>H<sub>16</sub>N<sub>4</sub>O<sub>2</sub>: C, 61.75; H, 5.92; N, 20.58. Found: C, 61.59; H, 5.98; N, 20.37.

#### EXAMPLE 116

##### Synthesis of $\alpha$ -Acetamido-N-benzyl-2-imidazole acetamide.

###### Preparation of 1-diethoxymethyl-2-lithioimidazole.

n-BuLi (2.5M in hexane, 6.8 mL, 17.0 mmol) was added to a cooled ( $-46^{\circ}$  C.) solution of 1-diethoxymethylimidazole (2.90 g, 17.06 mmol) in THF (45 mL) under N<sub>2</sub> atm. The solution was stirred at  $-46^{\circ}$  C. (15 min) to give the desired product.

##### Preparation of $\alpha$ -Acetamido-N-benzyl-2-imidazoleacetamide.

The 2-lithio salt solution of 1-diethoxymethylimidazole was added dropwise (15 min) into a cooled ( $-78^{\circ}$  C.) THF solution (130 mL) of 2-acetamido-N-benzyl-2-ethoxyacetamide (prepared from 2-acetamido-N-benzyl-2-ethoxyacetamide (2.00 g, 8.0 mmol) and  $\text{BBr}_3$  (1M in  $\text{CH}_2\text{Cl}_2$ , 10 mL, 10.0 mmol)). The reaction was stirred at  $-78^{\circ}$  C. (1 h) and then quenched with a saturated aqueous NH<sub>4</sub>Cl (50 mL) solution. The mixture was stirred at room temperature (30 min), and made basic ("pH" 9.2) by adding aqueous K<sub>2</sub>CO<sub>3</sub>. The aqueous mixture was extracted with  $\text{EtOAc}$  (3 $\times$ 100 mL), and the combined extracts were dried ( $\text{Na}_2\text{SO}_4$ ). The solvents were removed in vacuo and the residue was purified by flash column chromatography on  $\text{SiO}_2$  gel (2.5% MeOH/CHCl<sub>3</sub>) to give 0.14 g (7%) of the desired product: mp 228°–230° C. (recrystallized from EtOH);  $R_f$  0.46 (10% MeOH/CHCl<sub>3</sub>); IR (KBr) 3200 (br), 1610, 1500 (br), 1430, 1350, 740, 680  $\text{cm}^{-1}$ ; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.91 (s, C(O)CH<sub>3</sub>), 4.29 (d, J=5.6 Hz, CH<sub>2</sub>), 5.51 (d, J=7.7 Hz, CH), 6.85 (br s, C<sub>4</sub>H), 7.05 (br s, C<sub>5</sub>H), 7.18–7.30 (m, 5 PhH), 8.42 (d, J=7.7 Hz, NH), 8.65 (t, J=5.6 Hz, NH), 11.91 (br s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.49 (C(O)CH<sub>3</sub>), 42.21 (CH<sub>2</sub>), 51.62 (CH), 126.60 (C<sub>4</sub>), 126.98 (2C<sub>2</sub> or 2C<sub>3</sub>), 127.21 (C<sub>4</sub>), 128.09 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.32 (C<sub>5</sub>), 139.05 (C<sub>1</sub>), 143.74 (C<sub>2</sub>), 168.12 (C(O)NH), 169.30 (C(O)CH<sub>3</sub>) ppm; mass spectrum (FD) 273 (M<sup>+</sup>+1, 65), 272 (M<sup>+</sup>, 100).

Anal. Calcd for C<sub>14</sub>H<sub>16</sub>N<sub>4</sub>O<sub>2</sub>: C, 61.75; H, 5.92; N, 20.58. Found: C, 61.56; H, 5.92; N, 20.37.

#### EXAMPLE 117

##### Synthesis of $\alpha$ -Acetamido-N-benzyl-5-(tetrazole)acetamide.

A mixture of (2-acetamido-N-benzyl-2-cyanoacetamide (1.00 g, 4.33 mmol), potassium azide (1.70 g, 20.96 mmol) and  $\text{Et}_3\text{N}\cdot\text{HCl}$  (1.78 g, 13.0 mmol) in 1-methyl-2-pyrrolidinone (1.25 mL) was stirred at 110° C. (7 h). After cooling, aqueous concentrated HCl (1 mL) was added, and the reaction mixture was filtered. The solvent was removed in vacuo. The residue was dissolved in aqueous 1N NaOH (20 mL), and then aqueous 1N HCl (20 mL) was added. The precipitate was filtered to give 0.77 g (65%) of the desired product. The compound X was recrystallized from EtOH: mp 236°–238° C.;  $R_f$  0.20 (30% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.94 (s, C(O)CH<sub>3</sub>), 4.33 (d, J=5.7 Hz, CH<sub>2</sub>), 5.89 (d, J=7.8 Hz, CH), 7.18–7.33 (m, 5 PhH), 8.86 (d, J=7.8 Hz, NH), 8.92 (t, J=5.7 Hz, NH), 16.54 (br s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.21 (C(O)CH<sub>3</sub>), 42.37 (CH<sub>2</sub>), 48.13 (CH), 126.67 (C<sub>4</sub>), 127.00 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.05 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.52 (C<sub>1</sub>), 166.18 (C(O)NH), 169.58 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 275 (M<sup>+</sup>+1, 73), 274 (100). M<sub>r</sub> (+Cl) 274.119201 (calcd for C<sub>12</sub>H<sub>14</sub>N<sub>6</sub>O<sub>2</sub>; 274.117824).

#### EXAMPLE 118

##### Synthesis of $\alpha$ -Acetamido-N-benzyl-3-(1,2,4-triazole)acetamide.

An ethanolic solution (250 mL) of 2-acetamido-N-benzyl-2-cyanoacetamide (3.00 g, 13.0 mmol), formic hydrazide (1.60 g, 26.0 mmol) and K<sub>2</sub>CO<sub>3</sub> (6.00 g, 2.90 mmol) was heated at reflux (20 h). The reaction mixture was allowed to cool, filtered, and the solvent was removed in vacuo. The residue was purified by flash column chromatography on  $\text{SiO}_2$  gel using 13% MeOH/CHCl<sub>3</sub> as the eluent to give 1.40 g (40%) of the desired product. The compound

X was purified by recrystallization from EtOH: mp 205°–207° C.;  $R_f$  0.35 (16% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.92 (s, C(O)CH<sub>3</sub>), 4.30 (d,  $J$ =5.7 Hz, CH<sub>2</sub>), 5.62 (d,  $J$ =7.8 Hz, CH), 7.18–7.32 (m, 5 PhH), 8.53 (s, C<sub>5</sub>H), 8.56 (d,  $J$ =7.8 Hz, NH), 8.71 (t,  $J$ =5.7 Hz, NH), 13.98 (s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.48 (C(O)CH<sub>3</sub>), 42.41 (CH<sub>2</sub>), 51.30 (CH), 126.63 (C<sub>4</sub>), 127.08 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.11 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.05 (C<sub>1</sub>), 167.92 (C(O)NH), 169.32 (C(O)CH<sub>3</sub>); ppm; mass spectrum, FD (relative intensity) 274 (M<sup>+</sup>+1, 100), 273 (66).

Anal. Calcd for C<sub>13</sub>H<sub>15</sub>N<sub>5</sub>O<sub>2</sub>: C, 57.13; H, 5.53; N, 25.63. Found: C, 57.32; H, 5.57; N, 25.53.

### EXAMPLE 119

Synthesis of  $\alpha$ -Acetamido-N-benzyl-2-(carboxamide oxime)acetamide.

A suspension of NH<sub>2</sub>OH.HCl (1.80 g, 25.9 mmol), K<sub>2</sub>CO<sub>3</sub> (4.85 g, 35.0 mmol), 2-acetamido-N-benzyl-2-cyanoacetamide (2.00 g, 8.65 mmol) in absolute EtOH (150 mL) was heated at reflux (16 h). The reaction mixture was cooled, filtered, and concentrated under vacuum. The residue was purified by flash column chromatography on SiO<sub>2</sub> gel using 8% MeOH/CHCl<sub>3</sub> as the eluant to give 1.24 g (54%) of the desired product. The compound X was further purified by recrystallization from ethyl acetate/hexane: mp 172°–173° C.;  $R_f$  0.40 (10% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.87 (s, C(O)CH<sub>3</sub>), 4.27 (d,  $J$ =6.0 Hz, CH<sub>2</sub>), 4.88 (d,  $J$ =8.4 Hz, CH), 5.37 (s, NH<sub>2</sub>), 7.21–7.30 (m, 5 PhH), 8.21 (d,  $J$ =8.4 Hz, NH), 8.48 (t,  $J$ =6.0 Hz, NH), 9.28 (s, OH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.46 (C(O)CH<sub>3</sub>), 42.15 (CH<sub>2</sub>), 53.65 (CH), 126.60 (C<sub>4</sub>), 126.99 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.108 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.02 (C<sub>1</sub>), 149.63 (CNH<sub>2</sub>), 167.88 (C(O)NH), 169.07 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 265 (M<sup>+</sup>+1, 36), 264 (100).

Anal. Calcd for C<sub>12</sub>H<sub>16</sub>N<sub>4</sub>O<sub>3</sub>: C, 54.54; H, 6.10; N, 21.20. Found: C, 54.81; H, 6.01; N, 21.41.

### EXAMPLE 120

Synthesis of  $\alpha$ -Acetamido-N-benzyl-2-(carboxamide oxime-(O-acetate))acetamide.

To a stirred solution of  $\alpha$ -acetamido-N-benzyl-2-(carboxamide oxime)acetamide (0.72 g, 7.25 mmol) in pyridine (8 mL), acetyl chloride (0.25 mL, X mmol) was added dropwise. Upon addition of the acetyl chloride a small exotherm was detected (25° C. to 37° C.). The reaction mixture was stirred at room temperature (1 h). The solvent was then removed in vacuo, and the residue was dissolved in CH<sub>2</sub>Cl<sub>2</sub> (100 mL). The solution was washed with an aqueous 0.5N HCl solution (20 mL). The organic phase was dried (Na<sub>2</sub>SO<sub>4</sub>), and the solvent was removed in vacuo to give 0.60 g (72%) of the desired product. The compound X was recrystallized from chloroform/hexane: mp 131°–133° C.;  $R_f$  0.35 (4% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.90 (s, C(O)CH<sub>3</sub>), 2.06 (s, OC(O)CH<sub>3</sub>), 4.29 (t,  $J$ =5.3 Hz, CH<sub>2</sub>), 5.00 (d,  $J$ =8.4 Hz, CH), 6.48 (br s, NH<sub>2</sub>), 7.19–7.33 (m, 5 PhH), 8.29 (d,  $J$ =8.4 Hz, NH), 8.66 (t,  $J$ =5.3 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 19.86 (OC(O)CH<sub>3</sub>), 22.77 (C(O)CH<sub>3</sub>), 42.50 (CH<sub>2</sub>), 53.45 (CH), 126.89 (C<sub>4</sub>), 127.28 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.38 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.00 (C<sub>1</sub>), 156.13 (CNH<sub>2</sub>), 167.19 (C(O)NH), 168.49 (OC(O)CH<sub>3</sub>), 169.55 (C(O)CH<sub>3</sub>) ppm; mass spectrum, FD (relative intensity) 307 (M<sup>+</sup>+1, 100), 306 (43).

Anal. Calcd for C<sub>14</sub>H<sub>18</sub>N<sub>4</sub>O<sub>4</sub>: C, 54.89; H, 5.92; N, 18.29. Found: C, 54.86; H, 5.84; N, 18.19.

### EXAMPLE 121

Synthesis of  $\alpha$ -Acetamido-N-benzyl-3-(1,2,4-oxadiazole)acetamide.

76  
 $\alpha$ -Acetamido-N-benzyl-2-(carboxamide oxime)acetamide (0.90 g, 3.4 mmol) was dissolved in trimethylorthoformate (10 mL) containing BF<sub>3</sub>.Et<sub>2</sub>O (6 drops). The solution was warmed to 55° C. (20 min), and then evaporated under reduced pressure to give a white-blue solid. The material was dissolved in MeOH and treated with norit, filtered, and evaporated under reduced pressure to furnish crude product (0.79 g, 85%). The compound was purified by recrystallization from chloroform/hexane: mp 164°–166° C.;  $R_f$  0.37 (6% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.92 (s, C(O)CH<sub>3</sub>), 4.31 (d,  $J$ =6.0 Hz, CH<sub>2</sub>), 5.82 (d,  $J$ =8.4 Hz, CH), 7.15–7.34 (m, 5 PhH), 8.88 (d,  $J$ =8.4 Hz, NH), 8.96 (t,  $J$ =6.0 Hz, NH), 9.62 (s, C<sub>5</sub>H); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.22 (C(O)CH<sub>3</sub>), 42.35 (CH<sub>2</sub>), 49.44 (CH), 126.77 (C<sub>4</sub>), 127.06 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.18 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.70 (C<sub>1</sub>), 166.25 (C(O)NH), 166.74 (C<sub>3</sub>), 167.24 (C(O)CH<sub>3</sub>), 169.52 (C<sub>5</sub>, CH) ppm; mass spectrum, FD (relative intensity) 275 (M<sup>+</sup>+1, 28), 274 (100).  
Anal. Calcd for C<sub>13</sub>H<sub>14</sub>N<sub>4</sub>O<sub>3</sub>: C, 56.93; H, 5.14; N, 20.43. Found: C, 56.65; H, 5.01; N, 20.28.

### EXAMPLE 122

Synthesis of  $\alpha$ -Acetamido-N-benzyl-2-(thioamide)acetamide.

2-Acetamido-N-benzyl-2-cyanoacetamide (4.00 g, 34.64 mmol) and O,O-diethyldithiophosphoric acid (6.45 g, 34.64 mmol) were dissolved in a binary MeOH (80 mL)-EtOH (80 mL) solution containing H<sub>2</sub>O (0.32 mL) and heated at 70° C. (6 h) and then allowed to remain at room temperature (13 h). The reaction mixture was filtered, and the solvent was removed in vacuo. The residue was triturated with EtOAc to give 2.00 g (44%) of the desired compound. The thioamide was recrystallized from ethyl acetate/hexane: mp 170°–171° C.;  $R_f$  0.51 (8% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.93 (s, C(O)CH<sub>3</sub>), 4.29 (d,  $J$ =5.0 Hz, CH<sub>2</sub>), 5.21 (d,  $J$ =8.0 Hz, CH), 7.15–7.31 (m, 5 PhH), 8.03 (d,  $J$ =8.0 Hz, NH), 8.69 (t,  $J$ =5.0 Hz, NH), 9.27 (s, NH<sup>+</sup>), 9.91 (s, NHH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.68 (C(O)CH<sub>3</sub>), 42.24 (CH<sub>2</sub>), 62.95 (CH), 126.63 (C<sub>4</sub>), 126.96 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.087 (2C<sub>2</sub> or 2C<sub>3</sub>), 138.83 (C<sub>1</sub>), 166.42 (C(O)NH), 169.10 (C(O)CH<sub>3</sub>), 200.28 (C(S)NH<sub>2</sub>) ppm; mass spectrum, FD (relative intensity) 266 (M<sup>+</sup>+1, 42), 265 (100).  
Anal. Calcd for C<sub>12</sub>H<sub>15</sub>N<sub>3</sub>O<sub>2</sub>S: C, 54.32; H, 5.70; N, 15.84. Found: C, 54.44; H, 5.74; N, 15.54.

### EXAMPLE 123

Synthesis of Ethyl 2-Acetamido-2-vinylacetate.

Vinyl magnesium bromide (10.9 mL, 1N, 10.9 mmol) was slowly added to a cooled (–78° C.) solution of ethyl 2-acetamido-2-bromoacetate (1.10 g, 4.91 mmol) in THF (50 mL). The reaction was stirred at –78° C. (2 h), and was then quenched with a 1N citric acid solution (7.0 mL). The mixture was allowed to warm to room temperature, and then the THF was removed in vacuo. The aqueous mixture was extracted with CHCl<sub>3</sub> (3×100 mL), and the combined CHCl<sub>3</sub> extracts were dried (Na<sub>2</sub>SO<sub>4</sub>) and concentrated to dryness. The residue was purified by flash chromatography using SiO<sub>2</sub> gel and 2% MeOH/CHCl<sub>3</sub> as the eluant to give 0.50 g (60%) of the desired product as a light yellow colored oil:  $R_f$  0.51 (4% MeOH/CHCl<sub>3</sub>); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>)  $\delta$  1.17 (t,  $J$ =7.1 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 1.88 (s, C(O)CH<sub>3</sub>), 4.09 (d,  $J$ =7.1 Hz, OCH<sub>2</sub>CH<sub>3</sub>), 4.80–4.86 (m,  $\alpha$ -CH), 5.22–5.35 (m, CH=CH<sub>2</sub>), 5.82–5.92 (m, CH=CH<sub>2</sub>), 8.47 (d,  $J$ =7.4 Hz, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 13.96 (OCH<sub>2</sub>CH<sub>3</sub>), 22.12 (C(O)CH<sub>3</sub>), 54.65 ( $\alpha$ -CH), 60.71 (OCH<sub>2</sub>CH<sub>3</sub>), 117.89 (CH=CH<sub>2</sub>), 132.48 (CH=CH<sub>2</sub>), 169.16 (C(O)CH<sub>3</sub>), 170.26 (C(O)NH) ppm.

## EXAMPLE 124

## Synthesis of Vinyl Glycine.

A mixture of ethyl 2-acetamido-2-vinyl acetate (5.20 g, 30.40 mmol) and aqueous 6N HCl (200 mL) was heated to reflux (2 h). The mixture was cooled to room temperature, and then extracted with  $\text{CHCl}_3$  (3×100 mL). The aqueous solution which was dark brown in color was decolorized with norit (15 min) at 60° C., and then the mixture was filtered, and the filtrate was concentrated to dryness to give aude vinyl glycine hydrochloride. The salt was dissolved in a minimum amount of  $\text{H}_2\text{O}$  and acidified to pH 2.0 with aqueous 1N HCl. The solution was applied to an ion exchange resin (Dowex 50XW4, ammonium form) and eluted with  $\text{H}_2\text{O}$  until the eluate was neutral. The ion exchange column was then eluted with an aqueous 1N  $\text{NH}_4\text{OH}$  solution (~500 mL). Removal of volatile materials from the  $\text{NH}_4\text{OH}$  eluate gave 1.80 g (60%) of vinyl glycine: mp 218°–220° C. (d);  $^1\text{H}$  NMR ( $\text{D}_2\text{O}$ )  $\delta$  4.09 (d,  $J=7.2$  Hz,  $\alpha\text{-CH}$ ), 5.28–5.35 (m,  $\text{CH}=\text{CH}_2$ ), 5.80–5.87 (m,  $\text{CH}=\text{CH}_2$ ).

## EXAMPLE 125

## Synthesis of 2-Acetamido-2-vinylacetic acid.

Acetic anhydride (2.50 g, 24.50 mmol) was added slowly into a cooled (~10° C.) solution of vinyl glycine (2.20 g, 21.78 mmol) in  $\text{AcOH}$  (100 mL). The mixture was stirred at this temperature (30 min) and then at room temperature (3 h). The solution was concentrated repeatedly from  $\text{H}_2\text{O}$ . The residue was dissolved in absolute  $\text{EtOH}$  (200 mL) and then decolorized (norit, 60° C.), and filtered. The filtrate was concentrated in vacuo, and the residue was triturated with  $\text{Et}_2\text{O}$  to give 1.70 g (55%) of the desired product as a low melting yellow solid:  $^1\text{H}$  NMR ( $\text{DMSO-d}_6$ )  $\delta$  1.87 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 4.75 (dd,  $J=6.2$ , 7.5 Hz,  $\alpha\text{-CH}$ ), 5.13–5.27 (m,  $\text{CH}=\text{CH}_2$ ), 5.84–5.96 (m,  $\text{CH}=\text{CH}_2$ ), 8.24 (d,  $J=7.5$  Hz, NH).

## EXAMPLE 126

## Synthesis of 2-Acetamido-N-benzyl-2-vinylacetamide.

4-Methylmorpholine (0.71 g, 6.99 mmol) was added to a suspension of 2-acetamido-2-vinylacetic acid (1.00 g, 6.99 mmol) in  $\text{THF}$  (325 mL), and the mixture was stirred at room temperature (30 min). The reaction was cooled to ~10° to ~15° C. and then isobutylchloroformate (1.24 g, 9.08 mmol) was then added dropwise. After stirring (10 min), a solution of benzylamine (0.75 g, 6.99 mmol) in  $\text{THF}$  (25 mL) was added (15 min). The reaction mixture was allowed to warm to 0° C. The insoluble material was filtered. The filtrate was concentrated in vacuo, and the residue was purified by flash column chromatography on  $\text{SiO}_2$  gel using 3%  $\text{MeOH}/\text{CHCl}_3$  as the eluant to give 1.00 g (62%) of the desired product: mp 136°–138° C. (recrystallized from  $\text{EtOAc}$ );  $R_f$  0.24 (3%  $\text{MeOH}/\text{CHCl}_3$ );  $^1\text{H}$  NMR ( $\text{DMSO-d}_6$ )  $\delta$  1.88 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 4.27 (d,  $J=5.6$  Hz,  $\text{CH}_2$ ), 4.89–4.94 (dd,  $J=6.4$ , 7.8 Hz,  $\alpha\text{-CH}$ ), 5.13–5.30 (m,  $-\text{CH}=\text{CH}_2$ ), 5.81–5.93 (m,  $-\text{CH}=\text{CH}_2$ ), 7.20–7.33 (m, 5 PhH), 8.27 (c,  $J=7.8$  Hz, NH), 8.58 (t,  $J=5.6$  Hz, NH);  $^{13}\text{C}$  NMR ( $\text{DMSO-d}_6$ ) 22.47 ( $\text{C}(\text{O})\text{CH}_3$ ), 42.05 ( $\text{CH}_2$ ), 55.24 ( $\alpha\text{-CH}$ ), 116.44 ( $\text{CH}=\text{CH}_2$ ), 126.74 ( $\text{C}_4$ ), 127.05 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 128.24 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 134.76 ( $\text{CH}=\text{CH}_2$ ), 139.25 ( $\text{C}_1$ ), 168.78 ( $\text{C}(\text{O})\text{CH}_3$ ), 168.99 ( $\text{C}(\text{O})\text{NH}$ ) ppm.

## EXAMPLE 127

## Synthesis of 2-Acetamido-N-benzyl-2-epoxyacetamide.

A solution of 2-acetamido-N-benzyl-2-vinylacetamide (1.00 g, 4.31 mmol) and m-chloroperoxybenzoic acid (1.76

g, 55%, 5.60 mmol) in dichloromethane (100 mL) was stirred at room temperature (24 h), and then heated at reflux (3 h). The reaction solution was treated with a saturated aqueous  $\text{Na}_2\text{SO}_3$  solution (20 mL) and then the organic layer was extracted with a saturated aqueous  $\text{NaHCO}_3$  solution (3×50 mL). The organic layer was washed with a saturated aqueous  $\text{NaCl}$  solution and dried ( $\text{Na}_2\text{SO}_4$ ). The  $\text{CH}_2\text{Cl}_2$  was removed in vacuo, and the residue was then purified by flash column chromatography on  $\text{SiO}_2$  gel using 4%  $\text{MeOH}/\text{EtOAc}$  as the eluant to give 0.35 g (33%) of the desired product: mp 0° C. (recrystallized from  $\text{EtOAc}$ );  $R_f$  0.48 (5%  $\text{MeOH}/\text{CHCl}_3$ );  $^1\text{H}$  NMR ( $\text{DMSO-d}_6$ )  $\delta$  1.87 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 2.66 (dd,  $J=2.5$ , 5.0 Hz,  $\text{CH}(\text{O})\text{CHH}$ ), 2.75 (dd,  $J=4.3$ , 5.0 Hz,  $\text{CH}(\text{O})\text{CHH}$ ), 3.20 (m,  $\text{CH}(\text{O})\text{CHH}$ ), 4.25–4.32 (m,  $\alpha\text{-CH}_2$ ), 7.21–7.34 (m, 5 PhH), 8.30 (d,  $J=8.1$  Hz, NH), 8.59 (t,  $J=5.8$  Hz, NH);  $^{13}\text{C}$  NMR ( $\text{DMSO-d}_6$ ) 22.18 ( $\text{C}(\text{O})\text{CH}_3$ ), 41.99 ( $\text{CH}_2$ ), 43.91 ( $\text{CH}(\text{O})\text{CH}_2$ ), 51.30 ( $\text{CH}(\text{O})\text{CH}_2$ ), 53.80 ( $\alpha\text{-CH}$ ), 126.49 ( $\text{C}_4$ ), 126.83 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 127.98 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 138.86 ( $\text{C}_1$ ), 168.52 ( $\text{C}(\text{O})\text{NH}$ ), 169.24 (2 $\text{C}_2$  or 2 $\text{C}_3$ ) ppm.

## EXAMPLE 128

## Synthesis of Potassium 2-Acetamido-N-benzylacetamide-2-sulfonate.

A solution of 2-acetamido-N-benzyl-2-(trimethylammonium)acetamide tetrafluoroborate (0.30 g, 0.85 mmol) and  $\text{K}_2\text{SO}_3$  (0.68 g, 4.26 mmol) in  $\text{H}_2\text{O}$  (7.0 mL) was heated at 50°–55° C. (4 h). The solution was evaporated to dryness, and the residue was extracted with hot  $\text{MeOH}$  (3×10 mL). The  $\text{MeOH}$  was removed in vacuo to give a white solid (~30 mg):  $^1\text{H}$  NMR ( $\text{D}_2\text{O}$ )  $\delta$  1.97 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 4.33 ( $\text{CH}_2$ ), 5.45 (CH), 7.19–7.28 (m, 5 PhH);  $^{13}\text{C}$  NMR ( $\text{D}_2\text{O}$ ) 22.00 ( $\text{C}(\text{O})\text{CH}_3$ ), 43.41 ( $\text{CH}_2$ ), 67.77 (CH), 127.18 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 127.53 ( $\text{C}_4$ ), 128.83 (2 $\text{C}_2$  or 2 $\text{C}_3$ ), 137.58 ( $\text{C}_1$ ), 166.02 ( $\text{C}(\text{O})\text{NH}$ ), 173.65 ( $\text{C}(\text{O})\text{CH}_3$ ) ppm.

## EXAMPLE 129

## Synthesis of Ethyl 2-Acetamido-4-pentenoic acid ester.

Allyltrimethylsilane (4.09 g, 31.40 mmol) was added to a stirred solution of ethyl 2-acetamido-2-bromoacetate (1.76 g, 7.86 mmol) in dry  $\text{THF}$  (90 mL). After stirring (5 min), an ethereal solution of  $\text{ZnCl}_2$  (1N, 12.2 mL, 12.2 mmol) was added and the stirring was continued (70 h). The  $\text{THF}$  was removed by distillation in vacuo and the residue that remained was treated with  $\text{H}_2\text{O}$  (50 mL). The aqueous mixture was extracted with  $\text{CH}_2\text{Cl}_2$  (3×75 mL), the combined extract was dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated to give 1.40 g (97%) of the desired product. The ester was purified by distillation in vacuo (65°–70° C., 0.3–0.8 torr) to give the desired product as a colorless oil:  $R_f$  0.35 (3%  $\text{MeOH}/\text{CHCl}_3$ );  $^1\text{H}$  NMR ( $\text{CDCl}_3$ )  $\delta$  1.25 (t,  $J=6.8$  Hz,  $\text{OCH}_2\text{CH}_3$ ), 1.99 (s,  $\text{C}(\text{O})\text{CH}_3$ ), 2.44–2.60 (m,  $\text{CH}_2\text{CH}=\text{CH}_2$ ), 4.17 (q,  $J=6.8$  Hz,  $\text{OCH}_2\text{CH}_3$ ), 4.60–4.66 (m, CH), 5.07–5.11 (m,  $\text{CH}_2\text{CH}=\text{CH}_2$ ), 5.59–5.70 (m,  $\text{CH}_2\text{CH}=\text{CH}_2$ ), 6.15 (br s, NH);  $^{13}\text{C}$  NMR ( $\text{CDCl}_3$ ) 14.09 ( $\text{OCH}_2\text{CH}_3$ ), 23.00 ( $\text{C}(\text{O})\text{CH}_3$ ), 36.46 ( $\text{CH}_2\text{CH}=\text{CH}_2$ ), 51.58 (CH), 61.39 ( $\text{OCH}_2\text{CH}_3$ ), 118.95 ( $\text{CH}_2\text{CH}=\text{CH}_2$ ), 132.15 ( $\text{CH}_2\text{CH}=\text{CH}_2$ ), 169.64 ( $\text{C}(\text{O})\text{CH}_3$ ), 171.74 ( $\text{C}(\text{O})\text{OCH}_2\text{CH}_3$ ) ppm; mass spectrum, m/e (relative intensity) 186 ( $\text{M}^++1, 2$ ), 144 (19), 126 (7), 112 (31), 102 (73), 87 (18), 71 (100), 70 (89).

## EXAMPLE 130

## Synthesis of 2-Acetamido-4-pentenoic acid.

Ethyl 2-acetamido-4-pentenoic acid ester (1.20 g, 6.50 mmol) was dissolved in 90:5  $\text{EtOH}:\text{H}_2\text{O}$  (40 mL), and then

KOH (1.50 g, 26.80 mmol) was added and the resulting solution stirred at room temperature (48 h). The reaction was concentrated in vacuo and the residue diluted with H<sub>2</sub>O (15 mL) and then washed with Et<sub>2</sub>O (2x30 mL). The aqueous layer was then made acidic with 8.5% H<sub>3</sub>PO<sub>4</sub> and extracted with EtOAc (3x75 mL). The combined organic layers were dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated in vacuo to give 0.56 g (55%) of the desired product: mp 113°-115° C. (recrystallized from EtOAc); <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 2.00 (C(O)CH<sub>3</sub>), 2.43-2.65 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 4.36-4.43 (m, CH), 5.19-5.30 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 5.84-5.98 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 8.29 (d, J=7.7 Hz, NH), 12.78 (br s, OH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.35 (C(O)CH<sub>3</sub>), 35.44 (CH<sub>2</sub>CH=CH<sub>2</sub>), 51.68 (CH), 117.70 (CH<sub>2</sub>CH=CH<sub>2</sub>), 134.07 (CH<sub>2</sub>CH=CH<sub>2</sub>), 169.27 (C(O)CH<sub>3</sub>), 173.11 (CO<sub>2</sub>H) ppm; mass spectrum, m/e (relative intensity) 158 (M<sup>+</sup>+1, 2), 139 (6), 116 (20), 112 (8), 74 (73), 70 (47), 42 (100).

Anal. Calcd for C<sub>7</sub>H<sub>11</sub>NO<sub>3</sub>: C, 53.50; H, 7.06; N, 8.91. Found: C, 53.64; H, 7.15; N, 8.82.

### EXAMPLE 131

#### Synthesis of 2-Acetamido-4-pentenoic acid-N-benzylamide.

4-Methylmorpholine (0.55 g, 5.40 mmol) was added to a cooled (-10° to -15° C.) THF solution (60 mL) of 2-acetamido-4-pentenoic acid (0.81 g, 5.18 mmol), and then isobutylchloroformate (0.75 g, 5.70 mmol) was added leading to the precipitation of a white solid. After 2 min, a solution of benzylamine (0.61 g, 5.70 mmol) in THF (10 mL) was slowly added at -10° to -15° C. The reaction was allowed to warm (5 min) at room temperature and the insoluble salts were removed by filtration, and the filtrate was evaporated to dryness. The residue was triturated with EtOAc (10 mL), and the remaining white solid was filtered to give 0.81 g (64%) of the desired product: mp 118°-120° C. (recrystallized from ethyl acetate/cyclohexane); R<sub>f</sub> 0.36 (4% MeOH/CHCl<sub>3</sub>); IR (KBr) 3200 (br), 3040, 2900, 1650 (br), 1540 (br), 1350, 750, 700 cm<sup>-1</sup>; <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 1.83 (s, C(O)CH<sub>3</sub>), 2.22-2.49 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 4.26 (d, J=5.3 Hz, CH<sub>2</sub>Ph), 4.25-4.33 (m, CH), 4.99-5.09 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 5.65-5.77 (m, CH<sub>2</sub>CH=CH<sub>2</sub>), 7.21-7.29 (m, 5 PhH), 8.05 (d, J=7.6 Hz, NH), 8.46 (br s, NH); <sup>13</sup>C NMR (DMSO-d<sub>6</sub>) 22.41 (C(O)CH<sub>3</sub>), 36.24 (CH<sub>2</sub>CH=CH<sub>2</sub>), 41.91 (CH<sub>2</sub>Ph), 52.20 (CH), 117.15 (CH<sub>2</sub>CH=CH<sub>2</sub>), 126.54 (C<sub>4</sub>), 126.99 (2C<sub>2</sub> or 2C<sub>3</sub>), 128.04 (2C<sub>2</sub> or 2C<sub>3</sub>), 139.25 (C<sub>1</sub>), 134.25 (CH<sub>2</sub>CH=CH<sub>2</sub>), 169.02 (C(O)CH<sub>3</sub>), 170.96 (C(O)NH) ppm; mass spectrum, m/e (relative intensity) 246 (M<sup>+</sup>, 4), 205 (4), 163 (15), 140 (8), 106 (33), 91 (77), 70 (100).

Anal. Calcd for C<sub>14</sub>H<sub>18</sub>N<sub>2</sub>O<sub>2</sub>: C, 68.27; H, 7.37; N, 11.37. Found: C, 68.55; H, 7.31; N, 11.48.

### EXAMPLE 132

Using the procedures described herein, the following compounds can also be synthesized:

α-acetamido-N-benzyl-2-(2-oxazole)-acetamide

α-acetamido-N-benzyl-2-(2-thiazole)-acetamide.

#### Pharmacology.

Using male Carworth Farms #1 mice, compounds of the present invention were tested for anticonvulsant activity according to the following procedure: In the rotorod test, the animal was placed on a one-inch diameter knurled plastic rod rotating at 6 rpm after the administration of the drug. Normal mice can remain on a rod rotating at this speed indefinitely. Neurologic toxicity was defined as the failure of the animal to remain on the rod for one minute. In the horizontal screen test, previously trained mice were dosed

with the compound and placed individually on top of a square (13 cm×13 cm) wire screen (no. 4 mesh) which was mounted on a metal rod. The rod was rotated 180°, and the number of mice that returned to the top of the screen was determined. Inability to climb to the top within one minute was defined as "neurological impairment". This procedure is described in *Pharmacol. Biochem. Behav.* 6, 351-353 (1977) and is incorporated herein by reference with the same force and effect as if fully set forth herein.

The dose effect behavior of the compounds was evaluated using the above-described procedures by the administration of varying dose levels, treating normally eight mice at each dose. Table I includes an evaluation of the Median Effective Dose (ED50) and the Median Toxic Dose (TD50) of representative compounds. Mice were tested with varying doses of the anticonvulsant to define the limits of complete protection (or toxicity) and no protection (or no toxicity), as well as three points in between these limits. The Median Effective Dose (ED50) was defined as the dose which produced the desired endpoint in 50% of the animals. The Median Toxicity Dose (TD50) was the dose which elicited evidence of minimal neurological toxicity in 50% of the animals.

More specifically, data tabulated in Table I were generated as follows:

The compound was given in various dose levels (i.e., 10, 30, 100, 300 mg) and subsequently compared with phenytoin, phenobarbital, mephenytoin and phenacetamide (See Table I). N-Acetyl-D,L-alanine-N-benzylamide was tested at 600 mg/mL as well. Seizures were then artificially induced by either electroshock or pentylenetetrazole. Maximal electroshock seizures (MES) were elicited with a 60 cycle alternating current of 50 mA intensity (5-7 times that necessary to elicit minimal electroshock seizures) delivered for 0.2 sec via corneal electrodes. A drop of 0.9% saline was instilled in the eye prior to application of the electrodes so as to prevent the death of the animal. Protection in this test was defined as the abolition of the hind limb tonic extension component of the seizure. The Subcutaneous Pentylenetetrazole (Metrazol™) Seizure Threshold Test (sc Met) entailed the administration of 85 mg/kg of pentylenetetrazole as a 0.5% solution subcutaneously in the posterior midline. This amount of pentylenetetrazole was expected to produce seizures in greater than 95% of mice. The animal was observed for 30 minutes. Protection was defined as a failure to observe even a threshold seizure (a single episode of clonic spasms of at least 5 sec duration). The results of these tests are tabulated in Table I.

TABLE I

Compound	Comparative Median Effective Dosage		
	Tox TD50 mg/kg	MES ED50 mg/kg	sc Met ED50 mg/kg
N-acetyl-D,L-alanine-	454	77	≠
N-benzylamide	(417-501)*	(67-89)*	
N-acetyl-D-alanine-	214	55	55
N-benzylamide	(148-262)*	(50-60)*	(43-67)*
N-acetyl-L-alanine-	841	548	≠
N-benzylamide	(691-594)*	(463-741)*	
N-acetyl-D,L-phenylglycine-N-benzylamide	>>40	32.1	≠
N-acetyl-D-phenylglycine-N-benzylamide	>>80	26.4	≠
N-acetyl-L-phenylglycine-N-benzyl-	100-300	>300	≠

TABLE I-continued

-continued

Compound	Tbx	MES	sc Met	Tox	MES	scMet
	TD50 mg/kg	ED50 mg/kg	ED50 mg/kg	TD 50 mg/kg	ED 50 mg/kg	ED 50 mg/kg
amide				5		
D,L- $\alpha$ -acetamido-N-benzyl-3-thiophene-acetamide	>100	87.80	#	(N-methoxyamino)acetamide	(38.0 - 56.0)	(5.4-7.2)
D,L- $\alpha$ -acetamido-N-benzyl-2-thiophene-acetamide	30-100	44.80	#	2-acetamido-N-benzyl-2-(N,N-methylhydroxyamino))acetamide	#	-30
D,L- $\alpha$ -acetamido-N-benzyl-2-furan-acetamide	40	10.33	#	2-acetamido-N-benzyl-2-(N,N-dimethylhydroxyamino)acetamide	50.5**	6.7
D,L- $\alpha$ -acetamido-N-benzyl-2-pyrrole-acetamide	<100	16.10	#	2-acetamido-N-benzyl-2-(N-isoxazolidino)acetamide	(40.4-59.9)	(5.7-7.7)
D,L-2-acetamido-N-benzyl-2-ethoxy-acetamide	>112	62.01	#	2-acetamido-N-benzyl-2-(N <sup>2</sup> -phenylhydrazino)acetamide	#	31.4
D,L-2-acetamido-N-benzyl-2-methoxy-acetamide	<300	98.30	#	15 2-acetamido-N-benzyl-2-(N <sup>2</sup> -benzylloxycarbonylhydrazino)acetamide	(26.7-37.8)	-100
(D,L)- $\alpha$ -Acetamido-N-benzyl-2-(5-methylfuran)acetamide	75.4**	19.2 (16.4-23.8)*	#	2-acetamido-N-benzyl-2-(1-Pyrazolyl)acetamide	#	55.6
(D,L)- $\alpha$ -Acetamido-N-benzyl-2-benzofuran-acetamide	>100<300**	>100<300	#	2-acetamido-N-benzyl-2-(2-acetamido-N-benzyl-2-phenyloxycarbonylhydrazino)acetamide	(49.3-63.9)	#
(D,L)- $\alpha$ -Acetamido-N-benzyl-2-benzothiopheneacetamide	>100<300**	>100<300	#	2-acetamido-N-benzyl-2-(methylmercapto)acetamide	#	>100
(D,L)- $\alpha$ -Acetamido-N-benzyl-2-(5-methylpyrrole)acetamide	x	36.5 (30.6-57.1)*	#	2-acetamido-N-benzyl-2-(ethylmercapto)acetamide	#	#
(D,L)- $\alpha$ -Acetamido-N-(2-fluorobenzyl)-2-furan-acetamide	x	40.0	#	25 2-acetamido-N-benzyl-2-(S-thiophenoxy)acetamide	#	>30, <100
(D,L)- $\alpha$ -Acetamido-N-(3-fluorobenzyl)-2-furan-acetamide	135.6 (114.9-161.8)**	13.3 (11.5-15.3)*	#	2-acetamido-N-benzyl-2-(ethylmercapto)acetamide-S-oxide (diastereomer A)	#	#
				30 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide-S-oxide (diastereomers A + B)	#	>100
				2-acetamido-N-benzyl-2-(ethylsulfonyl)acetamide	#	#
				(D,L)- $\alpha$ -Acetamido-N-(4-fluorobenzyl)-2-furan-acetamide	144.4	12.7
				(D,L)- $\alpha$ -Acetamido-N-(2,5-difluorobenzyl)-2-furan-acetamide	(122.5-170.9)**	(10.4-15.1)*
				(D,L)- $\alpha$ -Acetamido-N-(2,6-difluorobenzyl)-2-furan-acetamide	x	23.8
				(D,L)- $\alpha$ -Acetamido-N-benzyl-2-furanacetamide	x	>25>100
				(D)-(-)- $\alpha$ -Acetamido-N-benzyl-2-furanacetamide	23.8**	3.3
				(L)-(+) $\alpha$ -Acetamido-N-benzyl-2-furanacetamide	>300	(2.8-3.9)*
2-acetamido-N-benzyl-2-aminoacetamide	#	65.1 (56.2-75.3)	#	(D,L)-2-Acetamido-4-pentenoic acid-N-benzylamide	x	33.6
2-acetamido-N-benzyl-2-(1-Pyrrolyl) acetamide	#	80.2	#	2-acetamido-N-benzyl-2-(2-Pyridyl) acetamide	#	8.5
2-acetamido-N-benzyl-2-(1-imidazo $\gamma$ 1) acetamide	#	>100	#	(D,L)-2-Acetamido-N-benzyl-2-(methylamino)acetamide	95.0	44.5
2-acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide	#	45.3	#	(D,L)-2-Acetamido-N-benzyl-3-phenylacetamide	x	(37.0-52.4)*
2-acetamido-N-benzyl-2-(4-morpholine)acetamide	#	>30, <100	#	50 2-(ethylamino)acetamide	x	42.4
2-acetamido-N-benzyl-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate	#	>100	#	(D,L)-2-Acetamido-N-benzyl-3-indoleacetamide	x	(37.2-47.8)*
2-acetamido-N-benzyl-2-(N-anilino)acetamide	#	>300	#	phenyton	66	10
2-acetamido-N-benzyl-2-(N-(3-pyrazolylamino))acetamide	#	-100	#	phenobarbital	69	not effective
2,2-diacetamido-N-benzyl-acetamide	#	>100, <300	#	mephenytoin	154	13
2-acetamido-N-benzyl-2-trifluoroacetamidoacetamide	#	>300	#	phenacetamide	421	31
2-acetamido-N-benzyl-2-(N-hydroxyamino)acetamide	#	-100	#	(337-549)*	(74-100)*	116
2-acetamido-N-benzyl-2-	46.0**	6.2	#	(71-150)*		

\*95% confidence intervals.

# or x The TD50 for this substrate was not computed.

\*\*The TD50 value was determined using the horizontal screen test.

xxx No activity was noted at  $\leq 300$  mg/kg

Other results from the pharmacological protocols are summarized in Tables II, III and IV.

TABLE II

Selected Physical and Pharmacological Data in Mice for  $\alpha$ -Acetamido-N-benzyl-2-furanacetamide (2)-Derivatives.<sup>a</sup>

CMP #	Ra	Rb	Rc			mp <sup>b</sup>	MES <sup>c</sup> ED <sub>50</sub> mg/kg	Tox <sup>d</sup> TD <sub>50</sub> mg/kg	PP
				X	Y				
3a		H	CH <sub>2</sub> CH <sub>2</sub> H <sub>5</sub>	O	O	159-161	51.7 (44.4-59.9)	f	—
3b		H	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	O	O	130-132	89.8 (78.4-103.4)	f	—
4		CH <sub>3</sub>	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	O	O	— <sup>b</sup>	>300	f	—
5		H	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	S	O	78-80	18.4 (15.9-22.0)	f	—
6		H	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	S	S	99-101	>100	f	—
7		H	CH <sub>2</sub> -	O	O	172-174	~30	f	—
8		H	CH <sub>2</sub> -	O	O	168-170	>100	f	—
9		H		O	O	159-161	~30	f	—
10		H		O	O	210-212	>100	f	—
11		H		O	O	226-228	>100	f	—
12		H		O	O	188-190	12.7 (10.4-15.1)	144 (123-171)	11.3
(R)-12		H		O	O	206-207	3.5 (2.9-4.4)	14.4 (7.3-28.9)	4.1

TABLE II-continued

Selected Physical and Pharmacological Data in Mice for  $\alpha$ -Acetamido-N-benzyl-2-furanacetamide (2)-Derivatives.\*

CMP #	Ra	Rb	Rc			MES <sup>a</sup>	ED <sub>50</sub> mg/kg	Tox <sup>d</sup>	TD <sub>50</sub> mg/kg	PI <sup>e</sup>
				X	Y					
(R)-13		H		CH <sub>3</sub> CNH—C(R <sub>b</sub> )—C(R <sub>a</sub> )—NH—R <sub>c</sub>	O	210-212	<10	f	—	
(R)-14		H			O	193-195	>10, <30	f	—	
phenytoin						9.5 (8.1-10.4)	65.5 <sup>f</sup> (52.5-72.1)	6.9		
phenobarbital						21.8 (15.0-22.5)	69.0 <sup>f</sup> (62.8-72.9)	3.2		
valproate						272 (247-338)	426 <sup>f</sup> (369-450)	1.6		

\*The compounds were administered intraperitoneally. ED<sub>50</sub> and TD<sub>50</sub> values are in milligrams per kilogram. Numbers in parentheses are 95% confidence intervals. Time of peak effects in hours as determined in the Experimental Section is denoted in brackets.

<sup>a</sup>Melting points (°C.) are uncorrected.

<sup>b</sup>MES = maximal electroshock seizure test. Compound was suspended in 30% PEG.

<sup>c</sup>Tox = neurologic toxicity determined from horizontal screen unless otherwise noted.

<sup>d</sup>PI = protective index (TD<sub>50</sub>/ED<sub>50</sub>).

f Not determined.

<sup>e</sup>Thick oil.

35

TABLE III

Selected Physical and Pharmacological Data in Mice for N-Substituted  $\alpha,\alpha$ -Diamino Acid Derivatives.\*

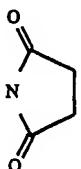
no	R <sup>2</sup>			MES <sup>c</sup>	tox <sup>d</sup>	45
		mp <sup>b</sup>	ED <sub>50</sub>			
2e	NHC(O)CH <sub>3</sub>		202-204	>30, <100	e	
2f	NHC(O)OPh		201-203	>100	e	
2g	NHC(O)NHCH <sub>3</sub>		229-230	>100	e	
2h	NHC(O)NHPH		242-244	>100	e	
2i	NHC(O)NHS(O <sub>2</sub> )Ph		188-191	>100	e	
2j	NHC(S)NHCH <sub>3</sub>		162-163	>100	e	
2k	NHC(S)NHPH		196-197	>100	e	
2l	NHC(O)Ph(2'-CO <sub>2</sub> H)		186-188	>100	e	
2m			181-183	>100	e	
2n	NHC(O)CH <sub>2</sub> NHC(O)OCH <sub>2</sub> Ph		177-179	>10, <30	e	
2o	NHCH <sub>2</sub> C(O)OCH <sub>2</sub> CH <sub>3</sub>		125-127	>100	e	
2p	NHCH <sub>2</sub> C(O)OCH <sub>2</sub> Ph		133-135	72	74	
2q	<sup>+</sup> NH <sub>2</sub> CH <sub>2</sub> CO <sub>2</sub> <sup>-</sup>		124-126			

TABLE III-continued

Selected Physical and Pharmacological Data in Mice for N-Substituted  $\alpha,\alpha$ -Diamino Acid Derivatives.\*

no	R <sup>2</sup>			MES <sup>c</sup>	tox <sup>d</sup>	45
		mp <sup>b</sup>	ED <sub>50</sub>			
	phenytoin				95 (8.1-10.4)	65.5 <sup>f</sup> (52.5-72.1)
	pheno-				21.8 (15.0-22.5)	69.0 <sup>f</sup> (62.8-72.9)
	barbital				22.5 (247-338)	72.9 (369-450)
	valproate				272 (247-338)	426 <sup>f</sup> (369-450)

\*The compounds were administered intraperitoneally. ED<sub>50</sub> and TD<sub>50</sub> values are in milligrams per kilogram. Numbers in parentheses are 95% confidence intervals. Time of peak effects in hours as determined in the Experimental Section is denoted in brackets.

<sup>b</sup>Melting points (°C.) are uncorrected.

<sup>c</sup>MES = maximal electroshock seizure test. Compound was suspended in 30% PEG unless otherwise noted.

<sup>d</sup>Tox = neurologic toxicity determined from horizontal screen unless otherwise noted.

e Not determined.

<sup>f</sup>Neurologic toxicity determined using the rotarod test.

TABLE IV

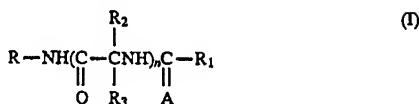
Pharmacological Data in Mice for $\alpha$ -Acetamido-N-Benzyl-2-Heterocyclic Derivatives			
$R_2$	MES <sup>a</sup>	tox <sup>b</sup>	TD <sub>50</sub>
	80.2	—	
	16.5	66.9 (55.6-81.1)	
	>100	—	
	>30, <100	—	
	>300	—	
	>100	—	
	>100	>100	
	>100	—	
	>100	—	

<sup>a</sup>MES = maximal electroshock seizure test. Compound was suspended in 30% PEG.

<sup>b</sup>TOX = neurologic toxicity determined from horizontal screen unless otherwise noted.

Thus, while the invention has been described with reference to certain preferred embodiments, those skilled in the art will realize that changes and modifications may be made thereto without departing from the full and intended scope of the appended claims.

What is claimed is:  
1. A compound of the formula



or the N-oxide thereof or pharmaceutically acceptable salts thereof wherein

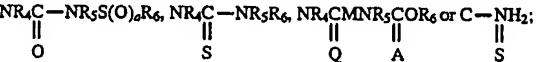
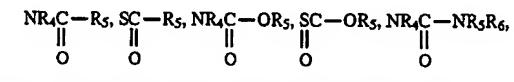
R is aryl, aryl lower alkyl, heterocyclic or heterocyclic lower alkyl, cycloalkyl, lower cycloalkyl, lower alkyl, wherein R is unsubstituted or is substituted with at least one electron withdrawing group or an electron donating group;

R<sub>1</sub> is hydrogen or lower alkyl, lower alkenyl, lower alkynyl, aryl lower alkyl, aryl, heterocyclic lower alkyl, heterocyclic lower cycloalkyl, lower cycloalkyl, lower alkyl, and R<sub>1</sub> is unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

R<sub>1</sub> and R<sub>3</sub> are independently hydrogen, lower alkyl lower alkenyl, lower alkynyl, heterocyclic, heterocyclic lower alkyl, lower alkyl heterocyclic, lower cycloalkyl, lower cycloalkyl lower alkyl, SO<sub>3</sub><sup>31</sup> or Z—Y wherein R<sub>2</sub> and R<sub>3</sub> may be unsubstituted or substituted with at least one electron withdrawing group or electron donating group;

Z is O, S(O)<sub>a</sub>, NR<sub>4</sub>, mercaptoalkyl, alkylthio; or a chemical bond;

Y is hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, lower alkynyl, halo, heterocyclic or heterocyclic lower alkyl, cycloalkyl, cycloalkyl lower alkyl and Y may be unsubstituted or substituted with an electron donating group or an electron withdrawing group provided that Z is a chemical bond only when Y is halo; or ZY taken together is NR<sub>4</sub>NR<sub>5</sub>R<sub>7</sub>, NR<sub>4</sub>OR<sub>5</sub>, ONR<sub>4</sub>R<sub>7</sub>, SNR<sub>4</sub>R<sub>7</sub>, NR<sub>4</sub>SR<sub>7</sub>, SPR<sub>4</sub>R<sub>5</sub>,



R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> are independently hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, or lower alkynyl, wherein R<sub>4</sub>, R<sub>5</sub> and R<sub>6</sub> may be unsubstituted or substituted with an electron withdrawing group or an electron donating group;

R<sub>7</sub> is R<sub>6</sub>, COOR<sub>8</sub> or COR<sub>8</sub>;

R<sub>8</sub> is hydrogen or lower alkyl or aryl lower alkyl;

n is 1-4 and

a is 1-3

55 M is a lower alkylene chain, and A and Q are independently O or S with the proviso that at least one of A or Q is S.

2. The compound, according to claim 1 wherein A is S.

3. The compound according to claim 1 wherein A and Q are S.

4. The compound according to claim 1 wherein one of R<sub>2</sub> and R<sub>3</sub> is H.

5. The compound according to claim 4 wherein one of R<sub>2</sub> and R<sub>3</sub> is H and the other is heterocyclic.

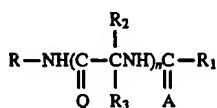
6. The compound according to claim 5 wherein heterocyclic is furyl, pyrrolyl, pyrazoyl, epoxy, oxazoyl, imidazoyl, tetraxoyl, triazoyl, or oxadiazoyl.

7. The compound according to claim 6 wherein heterocyclic is furyl, pyrrolyl, pyrozolyl, or pyridyl.

8. The compound according to claim 1 wherein one of  $R_2$  and  $R_3$  is H and the other is  $Z-Y$ .

9. The compound according to claim 8 wherein  $Z-Y$  is 5 N,O-dimethylhydroxyamino, N-methylhydroxyamino N-methoxyamino, ethylamino or methylamino or hydrazino.

10. A compound of the formula



or the N-Oxide thereof or pharmaceutically acceptable salts 15 thereof wherein

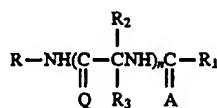
$R$  is aryl, aryl lower alkyl, heterocyclic or heterocyclic lower alkyl, cycloalkyl, lower cycloalkyl lower alkyl, wherein  $R$  is unsubstituted or is substituted with at least 20 one electron withdrawing group or an electron donating group;

$R_1$  is hydrogen or lower alkyl and  $R_1$  is unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

one of  $R_2$  and  $R_3$  is hydrogen, and the other is  $\text{SO}_3-$ , 25  $A$  and  $O$  are independently  $O$  or  $S$  and  $n$  is 1-4.

11. The compound according to claim 10 wherein  $Q$  and  $A$  are both O.

12. A compound of formula



or the N-Oxide thereof or pharmaceutically acceptable salts 35 thereof wherein

$R$  is aryl, aryl lower alkyl, heterocyclic or heterocyclic lower alkyl, cycloalkyl, lower cycloalkyl, lower alkyl, wherein  $R$  is unsubstituted or is substituted with at least 40 one electron withdrawing group or an electron donating group;

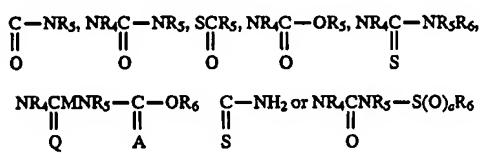
$R_1$  is hydrogen or lower alkyl and  $R_1$  is unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

$R_2$  and  $R_3$  are independently hydrogen, alkyl, or  $Z-Y$  wherein  $R_2$  and  $R_3$  may be unsubstituted or substituted with at least one electron withdrawing group or electron 45 donating group;

$Z$  is  $\text{S}(\text{O})_2$ , mercaptoalkyl, or alkylthio

$Y$  is hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, lower alkynyl, heterocyclic or heterocyclic lower alkyl, cycloalkyl, cycloalkyl lower alkyl and  $Y$  may be unsubstituted or substituted with an electron 55 donating group or an electron withdrawing group provided that when  $Y$  is halo,  $Z$  is a chemical bond; or

$ZY$  taken together is  $\text{NR}_4$



$R_4$ ,  $R_5$  and  $R_6$  are independently hydrogen, lower alkyl, aryl, aryl lower alkyl, lower alkenyl, or lower alkynyl,

wherein  $R_4$ ,  $R_5$  and  $R_6$  may be unsubstituted or substituted with an electron withdrawing group or an electron donating group;

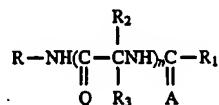
$n$  is 1-4 and

$a$  is 1-3

$M$  is lower alkylene, and  $A$  and  $Q$  are independently  $O$  or  $S$  with the proviso that at least one of  $R_2$  and  $R_3$  is  $Z-Y$ .

13. The compound of claim 12 wherein  $A$  and  $Q$  are both oxygen.

14. A compound of the formula

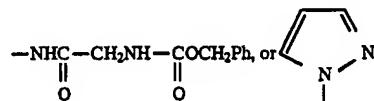


or the N-Oxide thereof or pharmaceutically acceptable salts thereof wherein

$R$  is aryl, aryl lower alkyl, heterocyclic or heterocyclic lower alkyl, cycloalkyl, lower cycloalkyl, lower alkyl, wherein  $R$  is unsubstituted or is substituted with at least one electron withdrawing group or an electron donating group;

$R_1$  is hydrogen or lower alkyl and  $R_1$  is unsubstituted or substituted with at least one electron withdrawing substituent or at least one electron donating substituent;

$R_2$  and  $R_3$  are independently hydrogen, amino, pyrrolyl, N, N-dimethylamino, morpholinyl, pyrazinyl,  $-\text{NH OCH}_3$ , methylhydroxyamino, (N,O-) dimethylhydroxyamino



or epoxy, and  $n$  is 1-4, provided that at least one of  $R_2$  and  $R_3$  is other than hydrogen.

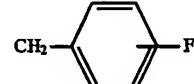
15. The compound according to claim 14 wherein  $Q$  and  $A$  are both O.

16. The compound according to any one of claims 1-15 wherein  $n$  is 1.

17. The compound according to any one of claims 1-15 wherein  $R$  is lower arylalkyl which is unsubstituted or substituted with an electron donating group or electron withdrawing group.

18. The compound according to claim 17 wherein  $R$  is 50 benzyl which is unsubstituted or substituted with an electron withdrawing group or electron donating group.

19. The compound according to claim 18 wherein  $R$  is unsubstituted benzyl or



20. The compound according to any of claims 1-15 wherein  $R_1$  is lower alkyl.

21. The compound according to claim 20 wherein  $R_1$  is methyl.

22. A compound selected from the group consisting of

65 ethyl 2-acetamido-2-aminoacetate, ethyl 2-acetamido-2-(methylamino)acetate, ethyl 2-acetamido-2-(N,N-dimethylamino)acetate, ethyl 2-acetamido-2-(4-

morpholine)acetate, ethyl 2-acetamido-2-(N-anilino)acetate, ethyl 2-acetamido-2-(N-(3-pyrazolylamino))acetate, ethyl 2-acetamido-2-(N-hydroxyamino)acetate, ethyl 2-acetamido-2-(N-(N-methylhydroxyamino))acetate, ethyl 2-acetamido-2-(N-(N,O-dimethylhydroxyamino))acetate, 2-acetamido-N-benzyl-2-aminoacetamide, 2-acetamido-N-benzyl-2-(methylamino)acetamide, 2-acetamido-N-benzyl-2-(ethylamino)acetamide, 2-acetamido-N-benzyl-2-(N-anilino)acetamide, 2-acetamido-N-benzyl-2-(N-(3-pyrazolylamino))acetamide, 2-acetamido-N-benzyl-2-(N,N-dimethylamino)acetamide, 2-acetamido-N-benzyl-2-(N-hydroxyamino)acetamide, 2-acetamido-N-benzyl-2-(N-hydroxyamino)acetamide, 2-acetamido-N-benzyl-2-(N<sup>2</sup>-phenylhydrazino)acetamide, 2-acetamido-N-benzyl-2-(N<sup>2</sup>-benzyloxycarbonylhydrazino)acetamide, 2-acetamido-N-benzyl-2-(methylmercapto)acetamide, 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide, 2-acetamido-N-benzyl-2-(N-methoxyamino)acetamide, 2-acetamido-N-benzyl-2-(N-(N-methylhydroxyamino))acetamide, 2-acetamido-N-benzyl-2-(N-(N,O-dimethylhydroxyamino))acetamide, 2-acetamido-N-benzyl-2-(N-isoxazolidino)acetamide, 2-acetamido-N-benzyl-2-hydroxyacetamide, 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide, 2,2-diacetamido-N-benzylacetamide, 2-acetamido-N-benzyl-2-trifluoracetamidoacetamide, 2-acetamido-N-benzyl-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate, 2-acetamido-N-benzyl-2-(ethylmercapto)acetamide-S-oxide, 2-acetamido-N-benzyl-2-(S-ethylmercapto)acetamide-S-oxide, 2-acetamido-N-benzyl-2-(ethanesulfonyl)acetamide, 2-acetamido-N-benzyl-2-(N,N,N-trimethylammonium)acetamide tetrafluoroborate, 2-acetamido-N-benzyl-2-(1-pyrrole)acetamide, 2-acetamido-N-benzyl-2-(1-imidazole)acetamide, 2-acetamido-N-benzyl-2-(1-pyrazole)acetamide, 2-acetamido-N-benzyl-2(1-(1,2,4-triazole))acetamide, 2-acetamido-N-benzyl-2(1-tetrazole)acetamide,  $\alpha$ -acetamido-N-benzyl-2-pyridylacetamide,  $\alpha$ -acetamido-N-benzyl-2-pyridyl acetamide N-oxide,  $\alpha$ -acetamido-N-benzyl-2-(S-thiophenoxy)-acetamide,  $\alpha$ -acetamido-N-benzyl-2-(tetrahydrofuran)acetamide, methyl  $\alpha$ -acetamido-2-methyl-2-furanacetate,  $\alpha$ -acetamido-2-methyl-2-furanacetamide,  $\alpha$ -thioacetamido-N-benzyl-2-furanacetamide,  $\alpha$ -thioacetamido-N-benzyl-2-furanthioacetamide,  $\alpha$ -acetamido-N-(3-pyridinylmethyl)-2-furanacetamide,  $\alpha$ -acetamido-N-(4-pyridinylmethyl)-2-furanacetamide,  $\alpha$ -acetamido-N-(1-oxo-3-pyridinylmethyl)-2-furanacetamide,  $\alpha$ -acetamido-N-(1-oxo-4-pyridinylmethyl)-2-furanacetamide, R(-) $\alpha$ -acetamido-N-(4-fluorobenzyl)-2-furanacetamide, R(-) $\alpha$ -acetamido-N-(4-trifluoromethylbenzyl)-2-furanacetamide, methyl [acetamido(benzylcarbamoyl)methyl]carbomate, phenyl [acetamido(benzylcarbamoyl)methyl]carbomate, 1-[acetamido(benzylcarbamoyl)methyl]-3-methylurea, 1-[acetamido(benzylcarbamoyl)methyl]-3-phenylurea, 1-[acetamido(benzylcarbamoyl)methyl]-3-benzenesulfonylurea, 1-[acetamido(benzylcarbamoyl)methyl]-3-methylthiourea, 1-[acetamido(benzylcarbamoyl)methyl]-3-phenylthiourea, N-[acetamido(benzylcarbamoyl)methyl]phthalamic acid, 2-acetamido-N-benzyl-2-(N-succinimidyl)acetamide, benzyl N-[acetamido(benzylcarbamoyl)methyl]malonamate, ethyl N-[acetamido(benzylcarbamoyl)methyl]glycinate, benzyl N-[acetamido(benzylcarbamoyl)methyl]glycinate, N-[acetamido(benzylcarbamoyl)methyl]glycine, 2-acetamide-N-benzyl-2-(1-pyrrole)acetamide,

2-acetamido-N-benzyl-2-(1-pyrazole)acetamide, 2-acetamido-N-benzyl-2-(1-imidazole)acetamide, 2-acetamido-N-benzyl-2-(1-(1,2,4-triazole))acetamide, 2-acetamido-N-benzyl-2-(1-tetrazole)acetamide, 5  $\alpha$ -acetamido-N-benzyl-1-(dimethylsulfamoyl)imidazole-4-acetamide,  $\alpha$ -acetamido-N-benzyl-4-imidazole acetamide,  $\alpha$ -acetamido-N-benzyl-5-(tetrazole)acetamide,  $\alpha$ -acetamido-N-benzyl-3-(1,2,4-triazole)acetamide,  $\alpha$ -acetamido-N-benzyl-2-(carboxamide oxime)acetamide,  $\alpha$ -acetamido-N-benzyl-2-(carboxamide oxime-(O-acetate))-acetamide,  $\alpha$ -acetamido-N-benzyl-3-(1,2,4-oxadiazole)acetamide,  $\alpha$ -acetamido-N-benzyl-2-(thioamide)acetamide, 2-acetamido-N-benzyl-2-vinylacetamide, 2-acetamido-N-benzyl-2-epoxyacetamide, potassium 2-acetamido-N-benzylacetamide-2-sulfonate, 2-acetamido-4-penten-1-oxime-N-benzylamide,  $\alpha$ -acetamido-N-benzyl-2-(2-oxazole)-acetamide, and  $\alpha$ -acetamido-N-benzyl-2-(2-thiazole)-acetamide.

23. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from any one of claims 1-15 and 22 and a pharmaceutical carrier therefor.

24. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from claim 16 and a pharmaceutical carrier therefor.

25. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from claim 17 and a pharmaceutical carrier therefor.

26. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from claim 18 and a pharmaceutical carrier therefor.

27. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound of claim 19 and a pharmaceutical carrier therefor.

28. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound of claim 20 and a pharmaceutical carrier therefor.

29. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound of claim 21 and a pharmaceutical carrier therefor.

30. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound according to any one of claims 1-15 and 22.

31. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 16.

32. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 17.

33. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 18.

34. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 19.

35. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 20.

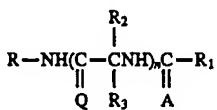
36. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of claim 21.

37. The compound according to any one of claims 1, 10, 12 or 14 wherein n is 1 and R is lower alkyl which is unsubstituted or substituted with an electron donating group or electron withdrawing group.

38. The compound according to any one of claims 1, 10, 12 or 14 wherein n is 1; R<sub>1</sub> is methyl and R is lower arylalkyl

which is unsubstituted or substituted with an electron withdrawing group or electron donating group.

39. A compound of the formula



or the pharmaceutically acceptable salts thereof wherein

$\text{R}$  is aryl, aryl lower alkyl, heterocyclic, heterocyclic lower alkyl, cycloalkyl or lower cycloalkyl lower alkyl, wherein  $\text{R}$  is unsubstituted or is substituted with at least one electron withdrawing group or an electron donating group;

$\text{R}_1$  is hydrogen or lower alkyl and  $\text{R}_1$  is unsubstituted or substituted with at least one electron withdrawing group or at least one electron donating group;

$\text{A}$  and  $\text{Q}$  are both O;

one of  $\text{R}_2$  and  $\text{R}_3$  is hydrogen and the other is lower alkyl which is substituted with an electron donating group or a electron withdrawing group and  $n$  is 1-4.

40. The compound according to claim 39 wherein one of  $\text{R}_2$  and  $\text{R}_3$  is hydrogen and the other is lower alkyl substituted with an electron donating group.

41. The compound according to claim 40 wherein one of  $\text{R}_2$  and  $\text{R}_3$  is alkyl substituted with an electron donating group wherein alkyl is methyl, ethyl, propyl, isopropyl, butyl, isobutyl, t-butyl, amyl or hexyl.

42. The compound according to claim 41 wherein one of  $\text{R}_2$  and  $\text{R}_3$  is methyl substituted with an electron donating group.

43. The compound according to claim 42 wherein the electron donating group is lower alkoxy.

44. The compound according to claim 43 wherein lower alkoxy is methoxy.

45. The compound according to any one of claims 39-44

15 wherein  $n$  is 1.

46. An anti-convulsant composition comprising an anti-convulsant effective amount of a compound from any one of claim 37-42 and a pharmaceutical carrier therefor.

47. A method of treating CNS disorders in an animal comprising administering to said animal an anti-convulsant effective amount of a compound of any one of claims 39-44.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 5,654,301  
DATED : August 5, 1997  
INVENTOR(S) : Harold Kohn, et al.

Page 1 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 34.

Line 59: "Ch<sub>3</sub> H)" should read -- C<sub>3</sub> H) --  
Line 59: "8.62 Hz" should read -- 8.62 (d,J=7.7 --  
Line 60: "H," should read -- Hz, --

Column 35.

Line 15: "form" should read -- formed --  
Line 35: "8.89" should read -- 8.99 --

Column 37.

Line 53: "a" should read -- 2 --  
Line 60: "or" should read -- of --

Column 38.

Line 65: "13<sub>c</sub>" should read -- 13 c --

Column 40.

Line 25: "2.33" should read -- 2.23 --  
Line 25: "425" should read -- 4.25 --  
Line 67: "(M<sup>30</sup>=1)" should read -- (M<sup>+</sup>= 1) --

Column 41.

Line 25: "2-hydroxyamino" should read -- 2-(N-hydroxyamino) --

Column 42.

Line 55: "(M<sup>+</sup> + 100)" should read -- (M<sup>+</sup> + 1,100) --

Column 19.

Line 30: "intraperitoncally" should read -- intraperitoneally --

Column 27.

Line 45: "16 ° " should read -- 169 ° --

Column 28.

Line 56: "7.1.7" should read -- 7.17 --

Column 30.

Line 37: "63" should read -- 6.3 --  
Line 64: "785" should read -- 735 --

UNITED STATES PATENT AND TRADEMARK OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 5,654.301  
DATED : August 5, 1997  
INVENTOR(S) : Harold Kohn, et al.

Page 2 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 31.

Line 21: "cbloroform" should read -- chloroform --  
Line 49: "2.78" should read -- 2.75 --

Column 33.

Line 16: "(D,L)" should read -- (D,L) --  
Line 38: "94:4" should read -- 96:4 --  
Lines 41 & 42: "80" should read -- 8.0 --  
Line 48: "C<sub>3</sub>" should read -- C<sub>6</sub> --

Column 34.

Line 15: "130" should read -- 139 --  
Line 41: "M + 1" should read -- M<sup>+</sup> + 1 --

Column 43.

Lines 21 & 49: "acetamido" should read -- acetamide --  
Line 59: "1.84" should read -- 1.84 --

Column 44.

Line 46, "n" should read -- a --  
Line 46: "ethoxyacetamido" should read -- ethoxyacetamide --  
Line 65: "acetamido" should read -- acetamide --

Column 45.

Line 18: after "spectrum" insert -- (FD) --  
Line 39: "7.5" should read -- 7.52 --  
Line 56: "73.3" should read -- 7.33 --

Column 46.

Line 25: "CH<sub>3</sub>Cl<sub>2</sub>," should read -- CH<sub>2</sub>Cl<sub>2</sub> --

Column 49.

Lines 57-58: "O-methylhydroxyamino" should read -- O-dimethylhydroxyamino --

Column 50.

Line 40: "149" should read -- 14.9 --

UNITED STATES PATENT AND TRADEMARK OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 5,654.301  
DATED : August 5, 1997  
INVENTOR(S) : Harold Kohn, et al.

Page 3 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 51.

Line 24: "accetamido" should read -- acetamide --  
Line 38: "Dicacetamido" should read -- Diacetamide --  
Line 46: "and-was" should read -- and was --

Column 52.

Line 16: "166.3.9" should read -- 166.39 --

Column 54.

Line 16: "Time" should read -- The --

Column 55.

Line 7: "H" should read -- It --

Column 56.

Line 55: "C<sub>1</sub>" should read -- C<sub>12</sub> --  
Line 66: "while" should read -- white --  
Line 66: "alter" should read -- after --

Column 58.

Line 30: "dr" should read -- dt --

Column 59.

Line 62: after "1.89" insert -- (s, --  
Line 63: Delete -- (s, --

Column 60.

Line 4: "1" should read -- 91 --

Column 61.

Line 30: "(C<sub>2</sub>), H" should read -- CH<sub>2</sub>), --

Column 63.

Line 38: "add" should read -- acid --

Column 65.

Line 10: "8.62" should read -- 8.61 --  
Line 21: "arthydride" should read -- anhydride --

UNITED STATES PATENT AND TRADEMARK OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 5,654.301  
DATED : August 5, 1997  
INVENTOR(S) : Harold Kohn, et al.

Page 4 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 66.

Line 34: "600" should read -- 670 --

Column 67.

Line 22: "63.72" should read -- 63.22 --

Line 63: "170.30" should read -- 170.03 --

Line 66: "N<sub>402</sub>" should read -- N<sub>4</sub> O<sub>2</sub> S --

Column 68.

Line 9: "while" should read -- white --

Line 67, "1.80" should read -- 181 --

Column 69.

Line 8: "176.5" should read -- 176.33 --

Lines 45-46: "Found: C,60.90; C, 61.16; H, 587; N, 1358.H, 5.77; N, 13.35." should read -- C, 61.16;H, 5.87; N, 13.58. Found: C, 60.90; H,5.77;N, 13.35. --

Line 57: "290" should read -- 20 --

Column 70.

Line 41: "2g" should read 2q --

Column 76.

Line 3: "BF3" should read -- BF<sub>3</sub> --

Line 37, "NHH" should read -- NHH' --

Column 81.

Line 47: "imidazo" should read -- imidazoyl --

Column 82.

Line 6: "38.0 . 56.0" should read -- 38.0-56.0 --

Column 83.

Line 15: "CH<sub>2</sub> CH<sub>6</sub> H<sub>5</sub>" should read -- CH<sub>2</sub>C<sub>6</sub> H<sub>5</sub> --

Column 84.

Line 63: "206" should read -- 205 --

Column 86.

Line 47: "95" should read -- 9.5 --

UNITED STATES PATENT AND TRADEMARK OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 5,654.301  
DATED : August 5, 1997  
INVENTOR(S) : Harold Kohn, et al.

Page 5 of 5

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 88, claim 1:

Line 24, "SO<sub>3</sub><sup>31</sup>" should read -- SO<sub>3</sub> --

Column 89, claim 10:

Line 26, "O" should read -- A and Q --

Column 90, claim 14:

Line 28, "R<sub>1</sub>" should read -- R<sub>2</sub> --

Column 90, claim 17:

Line 46, "1-15wherein" should read -- 1-16 wherein --

Column 90, claim 20:

Line 60, "1-15" should read -- 1-19 --

Signed and Sealed this

Twenty-seventh Day of November, 2001

Attest:

*Nicholas P. Godici*

Attesting Officer

NICHOLAS P. GODICI  
Acting Director of the United States Patent and Trademark Office

# **Exhibit E**



Customer No 124

ISTMT

DATE PRINTED  
11/21/2008

MASTER DATA CENTER, INC.  
29100 NORTHWESTERN HIGHWAY  
SUITE 300  
SOUTHFIELD MI 48034-1095

## MAINTENANCE FEE STATEMENT

According to the records of the U.S. Patent and Trademark Office (USPTO), the maintenance fee and any necessary surcharge have been timely paid for the patent listed below. The "PYMT DATE" column indicates the payment date (i.e., the date the payment was filed).

The payment shown below is subject to actual collection. If the payment is refused or charged back by a financial institution, the payment will be void and the maintenance fee and any necessary surcharge unpaid.

Direct any questions about this statement to: Mail Stop M Correspondence, Director of the USPTO, P.O. Box 1450, Alexandria, VA 22313-1450.

PATENT NUMBER	FEE AMT	SUR CHARGE	PYMT DATE	U.S. APPLICATION NUMBER	PATENT ISSUE DATE	APPL. FILING DATE	PAYMENT YEAR	SMALL ENTITY?	ATTY DKT NUMBER
5,654,301	\$850.00	\$0.00	02/02/01	08/003,208	08/05/97	01/12/93	04	NO	5352ZYXI-IIW



Customer No 124

ISTMT

DATE PRINTED  
11/21/2008

MASTER DATA CENTER, INC.  
29100 NORTHWESTERN HIGHWAY  
SUITE 300  
SOUTHFIELD MI 48034-1095

## MAINTENANCE FEE STATEMENT

According to the records of the U.S. Patent and Trademark Office (USPTO), the maintenance fee and any necessary surcharge have been timely paid for the patent listed below. The "PYMT DATE" column indicates the payment date (i.e., the date the payment was filed).

The payment shown below is subject to actual collection. If the payment is refused or charged back by a financial institution, the payment will be void and the maintenance fee and any necessary surcharge unpaid.

Direct any questions about this statement to: Mail Stop M Correspondence, Director of the USPTO, P.O. Box 1450, Alexandria, VA 22313-1450.

PATENT NUMBER	FEE AMT	SUR CHARGE	PYMT DATE	U.S. APPLICATION NUMBER	PATENT ISSUE DATE	APPL. FILING DATE	PAYMENT YEAR	SMALL ENTITY?	ATTY DKT NUMBER
5,654,301	\$2,150.00	\$0.00	12/03/04	08/003,208	08/05/97	01/12/93	08	NO	5352ZYXI-IIW

# Exhibit F

## Exhibit F

A brief description of significant activities undertaken by the sponsor, Schwarz Biosciences, Inc. ("Schwarz") (or its predecessor in interest), during the regulatory review period for VIMPAT® (lacosamide) injection, together with applicable dates, follows below.

### 1. Overview

Between November 14, 2003 and September 28, 2007, Schwarz conducted two clinical studies of VIMPAT® injection to identify the appropriate infusion duration(s) for VIMPAT® as short-term replacement for oral VIMPAT® and to provide data to support the safety of that infusion duration. Schwarz also conducted at least four pharmacokinetic and pharmacodynamic studies.

Between September 28, 2007 and October 28, 2008, Schwarz responded to numerous requests for information from FDA. The dates of those responses are summarized in Section 4.

### 2. Key Regulatory Dates

October 15, 2003	IND 68,407 submitted to FDA
November 14, 2003	FDA notification (via telephone) that IND 68,407 is in effect
December 24, 2003	FDA confirmation (via letter) that IND 68,407 is in effect <sup>1</sup>
December 9, 2004	End-of-Phase II Meeting with FDA
July 19, 2006	Pre-NDA Meeting with FDA
September 6, 2006	Meeting with FDA regarding abuse liability
September 28, 2007	NDA 22-254 submitted to FDA
October 22, 2007	FDA letter acknowledging receipt of NDA
December 10, 2007	FDA letter accepting NDA for filing
July 31, 2008	FDA letter extending NDA review date until October 28, 2008
October 28, 2008	FDA approval letter of NDA 22-254

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<sup>1</sup> Applicant notes that IND 57,939 for VIMPAT® (lacosamide) tablet went into effect on May 19, 1999. Thus, certain dates relating to that IND may be relevant should the FDA determine that the present application is entitled to that date. Applicant will supplement this Exhibit upon request should information from IND 57,939 be determined by the FDA to be relevant.

### 3. Summary of Phase III Clinical Studies

Start	Stop	Study
FSI 04 Mar 2004	LSO 17 Aug 2004	SP616 (multicenter, double-blind, double-dummy randomized study to investigate safety, tolerability, and pk of intravenous lacosamide as replacement for oral lacosamide in subjects with partial seizures with or without secondary generalization)
FSI 03 Feb 2005	LSO 10 May 2006	SP757 (multicenter, open-label study to investigate the safety and tolerability of intravenous lacosamide as replacement for oral lacosamide in subjects with partial seizures with or without secondary generalization)

### 4. NDA Amendments

Following the initial submission of the NDA on September 28, 2007, Schwarz submitted additional information to FDA on the following dates:

November 26, 2007	April 14, 2008	July 30, 2008
December 13, 2007	April 18, 2008	August 1, 2008
January 23, 2008	April 30, 2008	August 14, 2008
February 13, 2008	May 9, 2008	August 27, 2008
February 22, 2008	May 27, 2008	September 4, 2008
March 20, 2008	June 11, 2008	September 23, 2008
April 3, 2008	July 11, 2008 (2)	October 15, 2008
April 9, 2008	July 17, 2008	October 21, 2008

### 5. Additional Information

A more detailed description of the activities undertaken by the NDA holder, including those otherwise listed above in this Exhibit, is set forth in the IND 68,407 Submissions and NDA 22-254 Submissions tables (each table being produced across multiple pages that are independently numbered) produced on the remainder of the pages of this Exhibit.

# IND 68,407 Submissions

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
15-Oct-03	0000		Initial IND	SP616	Draft protocol		
15-Oct-03	0000		Initial IND		Evaluation of the pharmacokinetic profile of SPM 927		
15-Oct-03	0000		Initial IND		Investigator brochure		
15-Oct-03	0000		Initial IND	SP658	Randomized, open-label, single-dose, three-way crossover trial to compare the pharmacokinetics of SPM 927 when given a intravenous solution or as oral tablet in 24 healthy male subjects		
15-Oct-03	0000		Initial IND	SP643	Randomized, open-label, two-way crossover trial to investigate the pharmacokinetics and bioavailability of SPM 927 in poor and extensive metabolizers (cyp 2c19)		
15-Oct-03	0000		Initial IND		Cross reference all preclinical and clinical reports from oral IND.		
03-Nov-03			Response to FDA Request for Information		Send Tom Broadbent, FDA, fax of certificate of analysis for DS, rationale for vials filled with 21.0mL, and 20 L beaker.		
04-Nov-03			Response to FDA Request for Information		Send Tom Broadbent, FDA, fax of detailed information on vial and beakers for IV formulation.		

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
14-Nov-03		FDA Phone Contact			Ms. Griffis, FDA, calls with okay to proceed with IV trial SP616 and apology for comments on safety package being delayed.		
18-Nov-03	0001		Initial Safety Report	SP665		2003-00393	10344
19-Nov-03	0002	v1 p1	Information Amendment: Clinical	SP600	Open-label randomized, single dose, two-way cross-over study to evaluate the effect of food on the bioavailability of SPM 927 (harkoseride) in healthy male caucasian volunteers.		
19-Nov-03	0002	v3 p1	Information Amendment: Clinical	SP601	Open-label randomized, multiple dose, cross-over study to evaluate the pharmacokinetic effect of SPM 927 (harkoseride) on valproic acid (VPA) in 16 healthy male caucasian volunteers.		
02-Dec-03	0003		Follow-up Safety Report	SP667		2002-00244	12803/80017
03-Dec-03	0004		Follow-up Safety Report	SP655		2002-00095	10001/80037
05-Dec-03	0005		Initial Safety Report	SP667		2003-00287	10404/80291
05-Dec-03	0006		Follow-up Safety Report	SP615		2002-00044	10027/10027
08-Dec-03	0007		General Correspondence		Schwarz sends correction letter to 5-dec-2003 serial no. 0006. Incorrect version of CIOMS report was attached.		
17-Dec-03	0008		Follow-up Safety Report	SP615		2003-00248	10502

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
18-Dec-03	0009		Protocol Amendment: New Protocol	SP616	New protocol		
19-Dec-03	0010		Initial Safety Report	SP615		2003-00450	11488
23-Dec-03	0011		Follow-up Safety Report	SP667		2003-00287	10404/80291
24-Dec-03			FDA Correspondence	SP616	FDA sends IND review letter with comments and recommendations regarding clinical, pharmacokinetics, development plan and protocol SP616.		
30-Dec-03	0012		Initial Safety Report	SP615		2003-00474	11503
09-Jan-04	0013		Information Amendment: CMC Data		Revised CMC information including control of excipients, control of drug product and three month stability data for one batch of solution for injection.		
13-Feb-04	0014		Protocol Amendment: Change in Protocol	SP615	Amendment: 5		
13-Feb-04	0014		Information Amendment: Clinical	SP619	Open-label, randomized, single dose study to evaluate the absorption, metabolism, and excretion of [ <sup>14</sup> C]-labeled SPM 927 (harkoseride) following oral and intravenous administration to 10 healthy male caucasian subjects		
13-Feb-04	0014		Protocol Amendment: Change in Protocol	SP616	Amendment: 1		
13-Feb-04	0014		Response to FDA Request for Information		Schwarz responds to FDA letter 24-dec-2003 comments and recommendations.		

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
18-Feb-04	0015		Initial Safety Report	SP615		2004-00049	11281
24-Feb-04	0016		Follow-up Safety Report	SP615		2003-00474	11553
10-Mar-04	0017		General Correspondence	SP640	Submit pain protocol SP640 to epilepsy INDs for information purposes only.		
18-Mar-04	0018		Protocol Amendment: New Investigator	SP616	New investigators		
01-Apr-04	0019		Initial Safety Report	SP615		2004-00129	11610
01-Apr-04	0019		Initial Safety Report	SP665		2004-00135	10175
06-Apr-04	0020		Follow-up Safety Report	SP615		2003-00248	10501
15-Apr-04	0021		Follow-up Safety Report	SP665		2004-00135	10175
19-Apr-04	0022		Protocol Amendment: New Investigator	SP616	New and Revised investigators		
03-May-04	0023		Initial Safety Report	SP615		2004-00189	10185
12-May-04	0024		Follow-up Safety Report	SP615		2004-00129	11610
19-May-04	0026		Initial Safety Report	SP615		2004-00232	11478
20-May-04	0027		Protocol Amendment: New Investigator	SP616	New investigator		
27-May-04	0028		Follow-up Safety Report	SP615		2004-00049	11281

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
02-Jun-04			7-Day Safety Report	SP615	Fax 7-day safety report to Ms. Griffis, FDA.	2004-00274	11428
02-Jun-04	0029		7-Day Safety Report	SP615		2004-00274	11428
07-Jun-04	0030		Initial Safety Report	SP615		2004-00266	10194
21-Jun-04	0031		Protocol Amendment: New Investigator	SP616	New and revised investigators		
24-Jun-04	0032		Follow-up Safety Report	SP615		2004-00266	10194
24-Jun-04	0032		Follow-up Safety Report	SP615		2004-00274	11428
28-Jun-04	0033		Initial Safety Report	SP742		2004-00326	15502/800010
28-Jun-04	0033		Initial Safety Report	SP743		2004-00321	11406/8011
28-Jun-04	0034		Annual Report		Period covering 15-OCT-2004 through 25-MAR-2004		
01-Jul-04			Initial Safety Report	SP742		2004-00356	13002/800062
01-Jul-04			7-Day Safety Report	SP743	Fax 7-day safety reports to FDA	2004-00355	12307
01-Jul-04	0035		Follow-up Safety Report	SP667		2003-00298	11910/80301
01-Jul-04	0035		Follow-up Safety Report	SP615		2004-00232	11478
01-Jul-04	0036		7-Day Safety Report	SP743		2004-00355	12307

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
01-Jul-04	0036		Initial Safety Report	SP742		2004-00356	13002/80062
13-Jul-04	0037		Follow-up Safety Report	SP743		2004-00355	12307/80040
13-Jul-04	0037		Follow-up Safety Report	SP742		2004-00326	15502/80010
13-Jul-04	0038		Initial Safety Report	SP743		2004-00366	12302/80036
14-Jul-04			7-Day Safety Report	SP743	Fax Ms. Griffis, FDA, 7-day safety report	2004-00380	15712/80094
14-Jul-04	0039		7-Day Safety Report	SP743		2004-00380	15712/80094
19-Jul-04	0040		Initial Safety Report	SP742		2004-00370	13805/80082
21-Jul-04	0041		Information Amendment: Clinical	SP588	Multiple dose tolerance study with ascending oral doses of SPM 927 (harkosentide) in healthy male caucasian volunteers		
21-Jul-04	0042		Follow-up Safety Report	SP742		2004-00356	13002/80062
04-Aug-04			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00428	14309
04-Aug-04	0043		7-Day Safety Report	SP742		2004-00428	14309
05-Aug-04	0044		Follow-up Safety Report	SP615		2004-00266	10194
05-Aug-04	0044		Follow-up Safety Report	SP743		2004-00321	11406/80110
05-Aug-04	0044		Follow-up Safety Report	SP743		2004-00380	15712/80094

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
05-Aug-04	0044		Follow-up Safety Report	SP615		2004-00232	11478
09-Aug-04			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00441	15601/80177
09-Aug-04	0045		7-Day Safety Report	SP742		2004-00441	15601/80177
10-Aug-04	0046		Information Amendment: Clinical		Revised investigator's brochure dated May 2004		
12-Aug-04			7-Day Safety Report	SP743	Fax Ms. Griffis, FDA, 7-day safety report	2004-00447	17508/80301
12-Aug-04	0047		Follow-up Safety Report	SP742		2004-00428	14309/80133
12-Aug-04	0047		Follow-up Safety Report	SP742		2004-00370	13805/80082
12-Aug-04	0048		7-Day Safety Report	SP743		2004-00447	17508/80301
16-Aug-04	0049		Initial Safety Report	SP743		2004-00443	16811/80194
23-Aug-04	0050		Follow-up Safety Report	SP743		2004-00447	17508/80301
23-Aug-04	0050		Follow-up Safety Report	SP743		2004-00443	16811/80194
23-Aug-04	0050		Follow-up Safety Report	SP743		2004-00355	12307/80040
23-Aug-04	0050		Follow-up Safety Report	SP615		2003-00323	10616/10538
24-Aug-04			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00483	15210/80059

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
24-Aug-04	0051		7-Day Safety Report	SP742		2004-00483	15210/80059
25-Aug-04	0052		Response to FDA Request for Information	SP742	Respond to FDA request for follow-up information regarding this case; requested on 10-AUG-2004.	2004-00356	13002/80062
30-Aug-04	0053		Follow-up Safety Report	SP742		2004-00370	13805/80082
30-Aug-04	0053		Follow-up Safety Report	SP742		2004-00356	13002/80062
02-Sep-04			7-Day Safety Report Fax	SP743	Fax Ms. Griffis, FDA, 7-day safety report	2004-00507	14919
02-Sep-04	0054		7-Day Safety Report	SP743		2004-00507	14919
09-Sep-04	0055		Follow-up Safety Report	SP615		2004-00274	11428
09-Sep-04	0055		Follow-up Safety Report	SP743		2004-00447	17508/80301
09-Sep-04	0055		Follow-up Safety Report	SP743		2004-00443	16811/80194
09-Sep-04	0056		Meeting Request		Schwarz requests end of phase 2 type B meeting to discuss clinical development program for the iv formulation.		
14-Sep-04			FDA Phone Contact		Ms. Griffis, FDA, calls to give end of phase 2 meeting date of 9-DEC-2004.		
14-Sep-04			FDA Correspondence		Ms. Griffis, FDA, emails date of 9-DEC-2004 for end of phase 2 meeting.		

<i><b>Submission Date</b></i>	<i><b>Serial No</b></i>	<i><b>Location</b></i>	<i><b>Submission Type</b></i>	<i><b>Study No</b></i>	<i><b>Title/ Description</b></i>	<i><b>CIOMS Mfr Control No</b></i>	<i><b>CIOMS Subject No</b></i>
15-Sep-04		General Correspondence			Email Ms. Griffis, FDA, question on how the FDA will proceed with review of the CMC section.		
17-Sep-04		FDA Correspondence			Ms. Griffis, FDA, emails that once the briefing document is received she will have the chemist review it and determine if a meeting is needed.		
23-Sep-04	0057	7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00553	13308/80166	
23-Sep-04	0058	7-Day Safety Report	SP742		2004-00553	13308/80166	
27-Sep-04	0058	Initial Safety Report	SP742		2004-00544	15803	
27-Sep-04	0058	Initial Safety Report	SP742		2004-00551	14609	
29-Sep-04	0059	Follow-up Safety Report	SP742		2004-00428	14309/80133	
29-Sep-04	0059	Follow-up Safety Report	SP743		2004-00507	14919	
29-Sep-04	0059	Follow-up Safety Report	SP743		2004-00443	16811/80194	
08-Oct-04	0060	Initial Safety Report	SP615		2004-00573	10529	
13-Oct-04		7-Day Safety Report	SP615	Fax Ms. Griffis, FDA, 7-day safety report	2004-00580	10626	
13-Oct-04	0061	7-Day Safety Report	SP615		2004-00580	10626	
15-Oct-04		7-Day Safety Report	SP754	Fax Ms. Griffis, FDA, 7-day safety report	2004-00616	15605	

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15-Oct-04	0062		7-Day Safety Report	SP754		2004-00616	15605
19-Oct-04	0063		Follow-up Safety Report	SP754		2004-00616	15605
19-Oct-04	0063		Follow-up Safety Report	SP742		2004-00551	14609
19-Oct-04	0063		Follow-up Safety Report	SP742		2004-00553	13308/80166
19-Oct-04	0063		Follow-up Safety Report	SP742		2004-00544	15803
19-Oct-04	0063		Follow-up Safety Report	SP615		2004-00573	10529
20-Oct-04			FDA Correspondence		Ms. Griffis, FDA, emails that the chemist is reviewing the package.		
21-Oct-04			FDA Correspondence		Ms. Griffis, FDA, emails that the CMC team does not need to attend the 57,939 meeting as she hope to have CMC questions answered soon.		
25-Oct-04	0064		Initial Safety Report	SP743		2004-00614	17603/80422
26-Oct-04	0065		Meeting Package		End of phase 2 meeting package for meeting scheduled 9-DEC-2004.		
01-Nov-04	0066		Follow-up Safety Report	SP743		2004-00380	15712/80094
08-Nov-04			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00599	14004/80152
08-Nov-04	0067		7-Day Safety Report	SP742		2004-00599	14004/80152

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10-Nov-04	0068		Initial Safety Report	SP615		2004-00665	10402
12-Nov-04	0069		Follow-up Safety Report	SP742		2004-00551	14609
12-Nov-04	0069		Follow-up Safety Report	SP742		2004-00441	15601/80177
12-Nov-04	0069		Follow-up Safety Report	SP742		2004-00326	15502/80010
29-Nov-04	0070		Follow-up Safety Report	SP742		2004-00483	15210/80059
01-Dec-04	0071		Follow-up Safety Report	SP743		2004-00614	17603/80422
01-Dec-04	0071		Follow-up Safety Report	SP742		2004-00553	13308/80166
07-Dec-04	0072		Initial Safety Report	SP743		2004-00742	17029/80430
15-Dec-04	0073		Follow-up Safety Report	SP615		2004-00665	10402
21-Dec-04			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2004-00791	14806/80389
21-Dec-04			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report	2004-00790	112104/80001
21-Dec-04	0074		7-Day Safety Report	SP768		2004-00790	112104/80001
21-Dec-04	0074		7-Day Safety Report	SP742		2004-00791	14806/80389
22-Dec-04	0075		Follow-up Safety Report	SP743		2004-00742	17029/80430
22-Dec-04	0076		Initial Safety Report	SP746		2004-00778	17514

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22-Dec-04	0076		Initial Safety Report	SP755	Fax Ms. Griffis, FDA, 7-day safety report	2004-00815	11601/85761
28-Dec-04			7-Day Safety Report	SP755	Fax Ms. Griffis, FDA, 7-day safety report	2004-00815	106302/82234
28-Dec-04	0077		Protocol Amendment: New Protocol	SP757	New Protocol		
28-Dec-04	0078		7-Day Safety Report	SP755		2004-00815	106302/82234
03-Jan-05			FDA Correspondence		Ms. Griffis, FDA, emails that the meeting minutes are circulating at FDA for comments and lists the FDA attendees		
03-Jan-05	0079		Follow-up Safety Report	SP755		2004-00785	11601/85761
03-Jan-05	0079		Follow-up Safety Report	SP743		2004-00742	17029/80430
03-Jan-05	0079		Follow-up Safety Report	SP615		2004-00580	10626
06-Jan-05	0080		Information Amendment: CMC Data				
10-Jan-05	0081		Follow-up Safety Report	SP755		2004-00785	11601/85761
10-Jan-05	0081		Follow-up Safety Report	SP768		2004-00790	112104/80001
10-Jan-05	0081		Follow-up Safety Report	SP746		2004-00778	17514
10-Jan-05	0081		Follow-up Safety Report	SP742		2004-00599	14004/80152
13-Jan-05			7-Day Safety Report	SP755	Fax Ms. Griffis, FDA, 7-day safety report	2005-00008	122303/87995

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13-Jan-05	0082		7-Day Safety Report	SP755		2005-00008	122303/87995
19-Jan-05	0083		SB Meeting Minutes		Schwarz submits meeting minutes and related attachments from end of phase 2 meeting with FDA 9-DEC-2004. Requests FDA send meeting minutes to Schwarz.		
20-Jan-05			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2005-00051	14243/80369
20-Jan-05	0084		Initial Safety Report	SP755		2005-00015	110902/83890
20-Jan-05	0085		7-Day Safety Report	SP742		2005-00051	14243/80369
24-Jan-05	0086		7-Day Safety Report	SP742		2005-00059	12725/80373
24-Jan-05	0086		7-Day Safety Report	SP742		2005-00041	10911/80361
25-Jan-05			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report	2005-00061	111307/80163
25-Jan-05			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report	2005-00060	111305/80162
25-Jan-05	0087		7-Day Safety Report	SP768		2005-00061	111307/80163
25-Jan-05	0087		7-Day Safety Report	SP768		2005-00060	111305/80162
27-Jan-05	0088		Follow-up Safety Report	SP755		2005-00008	122303/87995
28-Jan-05			FDA Meeting Minutes		FDA emails meeting minutes from 9-DEC-2004 end of phase 2 meeting		

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28-Jan-05	0089		Initial Safety Report	SP755	Fax Ms. Griffis, FDA, 7-day safety report	2005-00049	118603/866661
01-Feb-05			7-Day Safety Report	SP755	Fax Ms. Griffis, FDA, 7-day safety report	2005-00077	10841/82989
01-Feb-05			7-Day Safety Report	SP742	Fax Ms. Griffis, FDA, 7-day safety report	2005-00088	14251/80421
01-Feb-05	0090		7-Day Safety Report	SP742		2005-00088	14251/80421
01-Feb-05	0090		7-Day Safety Report	SP755		2005-00077	10841/82989
02-Feb-05	0091		Follow-up Safety Report	SP768		2005-00060	111305/80162
02-Feb-05	0091		Follow-up Safety Report	SP768		2005-00061	111307/80163
02-Feb-05	0091		Follow-up Safety Report	SP755		2005-00015	110902/83890
02-Feb-05	0091		Follow-up Safety Report	SP755		2004-00785	116101/85761
04-Feb-05			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report	2005-00096	112703/80093
04-Feb-05	0092		7-Day Safety Report	SP768		2005-00096	112703/80093
04-Feb-05	0093		Follow-up Safety Report	SP742		2005-00041	10911/80361
04-Feb-05	0093		Follow-up Safety Report	SP742		2005-00059	12725/80373
04-Feb-05	0093		Follow-up Safety Report	SP742		2005-00051	14243/80369
09-Feb-05			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report	2005-00119	110403/80108

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09-Feb-05	0094		7-Day Safety Report	SP768			2005-00119	110403/80108
09-Feb-05	0095		Follow-up Safety Report	SP755			2005-00049	118603/886661
10-Feb-05	0096		Initial Safety Report	SP768			2005-00089	112909/80024
10-Feb-05	0096		Initial Safety Report	SP754			2004-00454	15103/80069
14-Feb-05	0097		Follow-up Safety Report	SP615			2004-00580	10626
14-Feb-05	0097		Follow-up Safety Report	SP768			2005-00096	112703/80093
14-Feb-05	0097		Follow-up Safety Report	SP755			2005-00077	108401/82989
14-Feb-05	0097		Follow-up Safety Report	SP742			2004-00791	14806/80389
14-Feb-05	0097		Follow-up Safety Report	SP742			2005-00088	14251/80421
15-Feb-05	0098		Follow-up Safety Report	SP615			2004-00189	10185
17-Feb-05	0099		Protocol Amendment: New Investigator	SP757		New investigator		
24-Feb-05	0100		Initial Safety Report	SP754			2005-00160	16102/80118
24-Feb-05	0100		Initial Safety Report	SP615			2004-00732	11280
01-Mar-05			7-Day Safety Report	SP746		Fax Ms. Griffis, FDA, 7-day safety report	2005-00170	14913

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01-Mar-05			7-Day Safety Report	SF745		Fax Ms. Griffis, FDA, 7-day safety report	2005-00168	175210
01-Mar-05	0101		7-Day Safety Report	SP745			2005-00168	175210
01-Mar-05	0101		7-Day Safety Report	SP746			2005-00170	14913
03-Mar-05	0102		Follow-up Safety Report	SP742			2005-00041	10911/80361
03-Mar-05	0102		Follow-up Safety Report	SP754			2004-00454	15103/80069
04-Mar-05	0103		7-Day Safety Report	SP755			2005-00185	116407/85873
08-Mar-05	0104		Initial Safety Report	SP756			2005-00177	15103
09-Mar-05	0105		7-Day Safety Report	SP742			2005-00193	12204/80037
11-Mar-05	0106		Initial Safety Report	SP743			2004-00444	177805/80350
14-Mar-05	0107		Follow-up Safety Report	SP754			2005-00160	16102/80118
14-Mar-05	0107		Follow-up Safety Report	SP745			2005-00168	175210
17-Mar-05	0108		Protocol Amendment: New Investigator	SP757		New investigators		
21-Mar-05	0109		Follow-up Safety Report	SP768			2005-00089	112909/80024
23-Mar-05	0110		Follow-up Safety Report	SP743			2004-00380	15712/80094

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23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00366	12302/80036
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00355	12307/80040
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00443	16811/80194
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00321	11406/80110
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00447	17508/80301
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00742	17029/80430
23-Mar-05	0110		Follow-up Safety Report	SP743		2004-00507	14919/80387
29-Mar-05	0111		Follow-up Safety Report	SP742		2005-00193	12204/80337
29-Mar-05	0111		Follow-up Safety Report	SP755		2005-00077	108401/82989
01-Apr-05	0112		Follow-up Safety Report	SP665		2002-00306	10141/10141
01-Apr-05	0112		Follow-up Safety Report	SP755		2005-00185	116407/85873
01-Apr-05	0112		Follow-up Safety Report	SP768		2005-00119	110403/80108
04-Apr-05	0113		Initial Safety Report	SP615		2005-00253	10476
12-Apr-05	0114		Follow-up Safety Report	SP746		2005-00170	14913
14-Apr-05	0115		Follow-up Safety Report	SP755		2005-00008	122303/87995

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14-Apr-05	01115		Follow-up Safety Report	SP742			2004-00428	14309/80133
25-Apr-05	01116		Follow-up Safety Report	SP746			2005-00177	15103
25-Apr-05	01116		Follow-up Safety Report	SP746			2005-00170	14913
26-Apr-05	01117		Protocol Amendment: New Investigator	SP757	New investigators			
26-Apr-05	01118		Initial Safety Report	SP768			2005-00303	101803/80331
02-May-05	01119		Follow-up Safety Report	SP768			2005-00119	110403/80109
02-May-05	01119		Follow-up Safety Report	SP768			2005-00303	101803/80331
02-May-05	01200		7-Day Safety Report	SP755			2005-00323	106406/82279
11-May-05	01211		Initial Safety Report	SP754			2005-00341	16013/80206
11-May-05	01211		Initial Safety Report	SP830			2005-00326	110503
18-May-05	01222		Follow-up Safety Report	SP615			2005-00253	10476
20-May-05			7-Day Safety Report	SP768	Fax Ms. Griffis, FDA, 7-day safety report		2005-00375	109308/80117
20-May-05	01233		7-Day Safety Report	SP768			2005-00375	109308/80117
24-May-05	01244		Initial Safety Report	SP768			2005-00358	108702/80471

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24-May-05	0124		Initial Safety Report	SP754		2005-00370	12804/80207
26-May-05	0125		Information Amendment: Pharmacology/Toxicology	LPT 13124/00	104-week carcinogenicity study of SPM 927 by oral administration to CD-1 mice		
26-May-05	0125		Information Amendment: Pharmacology/Toxicology	LPT 13295/00	104-week carcinogenicity study of SPM 927 by oral administration to CD-1 rats		
27-May-05			7-Day Safety Report	SP746	Fax Ms. Griffis, FDA, 7-day safety report	2005-00011	15009
27-May-05	0126		Follow-up Safety Report	SP755		2005-00077	108401/82989
27-May-05	0126		Follow-up Safety Report	SP742		2005-00193	12204/80337
27-May-05	0127		7-Day Safety Report	SP746		2005-00011	15009
01-Jun-05	0128		Protocol Amendment: Change in Protocol	SP757	Amendment 1		
02-Jun-05	0129		Information Amendment: Clinical	SP607	An open label, dose titration trial to determine tolerability and efficacy of oral SPM 927 as adjunctive therapy in patients with partial seizures with or without secondary generalization	2005-00405	110109/83605
03-Jun-05	0130		Initial Safety Report	SP755			
03-Jun-05	0130		Initial Safety Report	SP746		2005/00409	17014
06-Jun-05	0131		7-Day Safety Report	SP768		2005-00424	101410/80256
06-Jun-05	0132		Follow-up Safety Report	SP755		2005-00323	106406/82279

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07-Jun-05			FDA Correspondence		Ms. Griffis, FDA, provides contact information for Ms. Calder during her leave of absence		
15-Jun-05	0133		7-Day Safety Report	SP768		2005-00444	112305/80382
16-Jun-05	0134		Protocol Amendment: New Investigator	SP640	New investigator		
16-Jun-05	0134		Protocol Amendment: New Protocol	SP640	New protocol		
20-Jun-05	0135		Information Amendment: Clinical				
22-Jun-05	0136		Follow-up Safety Report	SP615		2004-00580	10626
23-Jun-05	0137		Request FDA Comment		Request bioequivalent for in vivo bioequivalence study for syrup; submit core text of SP643 and SP658		
23-Jun-05	0138		Initial Safety Report	SP746		2005-00441	17415
24-Jun-05	0139		Follow-up Safety Report	SP768		2005-00375	109308/80117
24-Jun-05	0139		Follow-up Safety Report	SP755		2005-00405	110109/83605
24-Jun-05	0139		Follow-up Safety Report	SP746		2005-00409	17014
24-Jun-05	0139		Follow-up Safety Report	SP768		2005-00424	101410/80256
27-Jun-05	0140		Initial Safety Report	SP755		2005-00206	108202/82918

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27-Jun-05	0140		Initial Safety Report	SP615		2005-00465	10477
27-Jun-05	0140		Initial Safety Report	SP756		2005-00467	16005
27-Jun-05	0141		Protocol Amendment: New Investigator	SP757	New investigators		
30-Jun-05	0142		Annual Report		period covering 26-MAR-2004 through 25-MAR-2005		
01-Jul-05	0143	v1 p1	Information Amendment: Clinical	678-02	Determination of SPM 927 and SPM 12809 in human plasma by HPLC Electrospray MS/MS after oral administration of SPM 927 and metformin to healthy male subjects (SP660)		
01-Jul-05	0143	v1 p136	Information Amendment: Clinical	679-02	Determination of SPM 927 and SPM 12809 in human urine by HPLC Electrospray MS/MS after oral administration of SPM 927 and metformin to healthy male subjects (SP660)		
01-Jul-05	0143	v2 p1	Information Amendment: Clinical	680-02	Determination of SPM 927 and SPM 12809 in human saliva by HPLC Electrospray MS/MS after oral administration of SPM 927 and metformin to healthy male subjects (SP660)		

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01-Jul-05	0143	v2 p64	Information Amendment: Clinical	031/04-05.MN	Validation of a LC/MS/MS method for the determination of metformin concentrations in human plasma and human urine samples and application of the validated assays to routine analysis of plasma and urine samples of study SP660	2005-00424	101410/80256
06-Jul-05	0144		Follow-up Safety Report	SP768			
06-Jul-05	0144		Follow-up Safety Report	SP756		2005-00444	112305/80382
06-Jul-05	0144		Follow-up Safety Report	SP768		2005-00467	16005
07-Jul-05	0145		Information Amendment: Pharmacology/Toxicology	750-03	Determination of SPM 927 and SPM 12809 in rat plasma by HPLC electrospray MS after oral administration of lacosamide to juvenile rats in a dose-range-finding study (LPT 18601/04)		
08-Jul-05	0146		Information Amendment: Clinical	SP642	Open, non-randomized, group comparison to investigate the pharmacokinetics, safety, and tolerability of 100mg SPM 927 twice daily in male and female subjects with hepatic impairment compared w/ male and female healthy subj following multiple-dose admin		
11-Jul-05			FDA Correspondence		FDA mails clarification letter to respond to a number of questions as a result of agency letter 16-MAR-2005 requesting possibly suicide related evaluation of AEs occurring in lacosamide trials		

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12-Jul-05				FDA Correspondence				
14-Jul-05	0147			Initial Safety Report	SP755		2005-00493	106305/822237
14-Jul-05	0148			Follow-up Safety Report	SP768		2005-00375	109308/80117
14-Jul-05	0148			Follow-up Safety Report	SP754		2005-00341	16013/80206
14-Jul-05	0148			Follow-up Safety Report	SP615		2004-00580	10626
18-Jul-05				7-Day Safety Report	SP830	Fax Ms. Griffis, FDA, 7-day safety report	2005-00211	108301
18-Jul-05	0149			Initial Safety Report	SP756		2005-00512	15001
18-Jul-05	0149			Initial Safety Report	SP830		2005-00492	112007
18-Jul-05	0150			7-Day Safety Report	SP830		2005-00211	108301
20-Jul-05	0151			Protocol Amendment: New Investigator	SP757	Revised Investigator		
20-Jul-05	0152			Follow-up Safety Report	SP830		2005-00492	112007
21-Jul-05	0153			Follow-up Safety Report	SP755		2005-00493	106305/822237
21-Jul-05	0153			Follow-up Safety Report	SP768		2005-00444	112305/80382

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21-Jul-05	0153		Follow-up Safety Report	SP746		2005-00441	17415
25-Jul-05	0154		7-Day Safety Report	SP768		2005-00545	108808/80185
27-Jul-05	0155		Information Amendment: Clinical	SP586	A phase II, multicenter, ascending dose assessment of the safety, tolerability, compatibility, efficacy, and pharmacokinetics of harkoside (ADD 234037) as adjunctive therapy in patients with partial seizures		
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00551	14609/80056
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00553	13308/80166
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00599	14004/80152
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00791	14806/80389
28-Jul-05	0156		Follow-up Safety Report	SP742		2005-00041	10911/80361
28-Jul-05	0156		Follow-up Safety Report	SP742		2005-00051	14243/80369
28-Jul-05	0156		Follow-up Safety Report	SP742		2005-00059	12725/80373
28-Jul-05	0156		Follow-up Safety Report	SP742		2005-00193	12204/80337
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00544	15803/80047
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00326	15502/80010

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28-Jul-05	0156		Follow-up Safety Report	SP742		2005-00088	14251/80421
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00441	15601/80177
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00428	14309/80133
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00370	13805/80082
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00356	13902/80062
28-Jul-05	0156		Follow-up Safety Report	SP742		2004-00483	15210/80059
28-Jul-05	0157		Follow-up Safety Report	SP756		2005-00512	15001
29-Jul-05	0158		7-Day Safety Report	SP768		2005-00556	106313/80468
29-Jul-05	0158		7-Day Safety Report	SP768		2005-00552	102704
29-Jul-05	0159		Initial Safety Report	SP768		2005-00544	114721/80494
29-Jul-05	0159		Initial Safety Report	SP768		2005-00533	103902
05-Aug-05	0160		Follow-up Safety Report	SP768		2005-00545	108808/80185
05-Aug-05	0160		Follow-up Safety Report	SP768		2005-00556	106313/80468
05-Aug-05	0160		Follow-up Safety Report	SP830		2005-00211	108301

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
08-Aug-05	0161		Information Amendment: CMC Data		Submit revised CMC information for drug substance and drug product with reference report PhTox 2678		
10-Aug-05	0162		Initial Safety Report	SP746		2005-00503	13706
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	LPT 18772/05	Determination of SPM 927, desmethyl-SPM 927 and desacetyl-SPM 927 concentrations in mouse plasma		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	LPT 18447/04	Single dose pharmacokinetics of SPM 927 in CD®-1 mice		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	0699/025	( <sup>14</sup> C)-SPM 927: Metabolism in hepatocytes isolated from mouse, rat, rabbit, dog and man		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	688	Investigation of the metabolism of SPM 927 in different in vitro models		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	668	Evaluation of the in vivo metabolism of SPM 927 to SPM 12809 in mice, rats and dogs following repeated oral administration of SPM 927		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	0699/023	( <sup>14</sup> C)-SPM 927: A study of absorption, metabolism and excretion following single and multiple oral administration to the rat		
10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	728	Assessment of the systemic exposure to SPM 927, its desmethyl and its desacetyl metabolite in a single dose pharmacokinetic study of SPM 927 in male mice (188447/04, LPT)		

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10-Aug-05	0163		Information Amendment: Pharmacology/Toxicology	750-03	Determination of SPM 927 and SPM 12809 in rat plasma by HPLC-Electrospray MS after oral administration of lacosamide to juvenile rats in a dose-range-finding study (LPT 18601/04)		
15-Aug-05	0164		Information Amendment: Clinical	606-03	Re-validation of a solid-phase radioimmunoassay for determination of digoxin in human serum		
15-Aug-05	0164		Information Amendment: Clinical	682-03	Determination of SPM 927 in human plasma by HPLC Electrospray MS/MS after oral administration of SPM 927 (SP690)		
15-Aug-05	0164		Information Amendment: Clinical	651	Transport of SPM 927 across Caco-2 monolayer-Investigation of P-glycoprotein involvement		
15-Aug-05	0164		Information Amendment: Clinical	607-03	Re-validation of a solid-phase radioimmunoassay for determination of digoxin in human urine	2005-00597	111308
15-Aug-05	0165		7-Day Safety Report	SP745		2005-00545	108808/80185
17-Aug-05	0166		Follow-up Safety Report	SP768		2005-00441	17415
17-Aug-05	0166		Follow-up Safety Report	SP746		2005-00556	106313/80468
19-Aug-05	0167		Follow-up Safety Report	SP830		2005-00211	108301
22-Aug-05	0168		Initial Safety Report	SP615		2004-00543	10628

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24-Aug-05	0169		Initial Safety Report	SP745		2005-00527	170412
24-Aug-05	0169		Initial Safety Report	SP755		2005-00602	124609/88827
24-Aug-05	0169		Initial Safety Report	SP830		2005-00619	105619
25-Aug-05	0170		7-Day Safety Report	SP745		2005-00626	172706
26-Aug-05	0171		Follow-up Safety Report	SP768		2005-00552	102704
29-Aug-05	0172		7-Day Safety Report	SP768		2005-00634	104610/80545
01-Sep-05	0173		Follow-up Safety Report	SP830		2005-00619	105619
01-Sep-05	0173		Follow-up Safety Report	SP745		2005-00626	172706
01-Sep-05	0174		Initial Safety Report	SP756		2005-00635	11501
01-Sep-05	0174		Initial Safety Report	SP745		2005-00631	111607
08-Sep-05	0175		Initial Safety Report	SP640		2005-00636	82043
08-Sep-05	0175		Initial Safety Report	SP768		2005-00643	109138
08-Sep-05	0176		Follow-up Safety Report	SP746		2005-00503	13706
08-Sep-05	0176		Follow-up Safety Report	SP745		2005-00631	111607
08-Sep-05	0176		Follow-up Safety Report	SP755		2005-00323	106406/82279

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08-Sep-05	0176		Follow-up Safety Report	SP745		2005-00626	172706
13-Sep-05	0177		7-Day Safety Report	SP863		2005-00662	80011/80011
13-Sep-05	0178		Initial Safety Report	SP756		2005-00649	12603
19-Sep-05	0179		Follow-up Safety Report	SP756		2005-00635	11501
19-Sep-05	0179		Follow-up Safety Report	SP830		2005-00619	105619
19-Sep-05	0179		Follow-up Safety Report	SP768		2005-00634	104610/80545
19-Sep-05	0179		Follow-up Safety Report	SP755		2005-00206	108202/822918
20-Sep-05	0180		Protocol Amendment: New Investigator	SP757	New and revised investigators		
20-Sep-05	0181		Information Amendment: Clinical	SP645	Randomized, open-label, single-dose, 2-way crossover trial to compare the pharmacokinetics of SPM 927 when given as intravenous solution or as oral tablet in healthy male subjects		
26-Sep-05	0182		Follow-up Safety Report	SP768		2005-00544	114721/80494
26-Sep-05	0182		Follow-up Safety Report	SP768		2005-00643	109138
26-Sep-05	0182		Follow-up Safety Report	SP768		2005-00358	108702/80471
29-Sep-05	0183		Initial Safety Report	SP774		2005-00648	104109

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03-Oct-05	0184		Follow-up Safety Report	SP768			2005-00552	102704
03-Oct-05	0184		Follow-up Safety Report	SP756			2005-00649	12603
03-Oct-05	0184		Follow-up Safety Report	SP756			2005-00467	16005
11-Oct-05	0185		Follow-up Safety Report	SP745			2005-00527	170412
11-Oct-05	0185		Follow-up Safety Report	SP746			2005-00503	13706
11-Oct-05	0185		Follow-up Safety Report	SP755			2005-00602	124609/88827
11-Oct-05	0185		Follow-up Safety Report	SP756			2005-00635	11501
11-Oct-05	0185		Follow-up Safety Report	SP830			2005-00492	112007
13-Oct-05	0186		Initial Safety Report	SP830			2005-00645	111205
20-Oct-05	0187		Protocol Amendment: New Investigator	SP757	New and revised investigators			
26-Oct-05	0188		Follow-up Safety Report	SP830			2005-00492	112007
26-Oct-05	0188		Follow-up Safety Report	SP755			2005-00206	108202/82918
28-Oct-05	0189		7-Day Safety Report	SP768			2005-00744	108217/80452
01-Nov-05	0190		Follow-up Safety Report	SP755			2005-00323	106406/82279

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03-Nov-05	0191		Initial Safety Report	SP615		2005-00738	11614
08-Nov-05	0192		Initial Safety Report	SP768		2005-00750	104214
08-Nov-05	0192		Initial Safety Report	SP615		2003-00367	11776
08-Nov-05	0193		Follow-up Safety Report	SP830		2005-00645	111205
10-Nov-05	0194		General Correspondence		Notify FDA of change in address and fax number		
16-Nov-05	0195		Follow-up Safety Report	SP745		2005-00597	111308
16-Nov-05	0195		Follow-up Safety Report	SP830		2005-00492	112007
22-Nov-05	0196		Initial Safety Report	SP754			
30-Nov-05	0197		Information Amendment: Clinical	SP690	An open-label follow-on trial to assess the long-term safety and efficacy of oral SPM 927 in subjects with posttherapeutic neuralgia (PHN)	2005-00775	12512/80299
30-Nov-05	0197		Information Amendment: Clinical	SP611	An open-label trial to assess the efficacy and safety of ascending doses of SPM 927 in subjects with chronic refractory neuropathic pain		
02-Dec-05	0198		General Correspondence		Request finalized list of FDA attendees and anticipated date of preliminary response to questions submitted in pre-NDA meeting package (Serial No. 3326); submit list of Schwarz attendees		

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05-Dec-05	0199		Follow-up Safety Report	SP768		2005-00096	112703/80093
07-Dec-05	0200		Initial Safety Report	SP774		2005-00803	110505/83749
08-Dec-05	0201		Follow-up Safety Report	SP863		2005-00662	80011/80011
13-Dec-05	0202		Response to FDA Request for Information		Submit information requested by Dr. Broadbent, FDA, for verification that both the masking agent and the strawberry flavoring are Generally Recognized as Safe (GRAS)		
14-Dec-05	0203		Follow-up Safety Report	SP615		2005-00465	10477
14-Dec-05	0203		Follow-up Safety Report	SP768		2005-00552	102704
15-Dec-05	0204		Initial Safety Report	SP830		2005-00821	110604
19-Dec-05	0205		Follow-up Safety Report	SP768		2005-00060	111305/80162
19-Dec-05	0205		Follow-up Safety Report	SP615		2005-00253	10476
20-Dec-05	0206		Initial Safety Report	SP745		2005-00827	108112
21-Dec-05	0207		Follow-up Safety Report	SP774		2005-00803	110505/83749
21-Dec-05	0208		Protocol Amendment: New Investigator	SP757	New investigator		
27-Dec-05	0209		7-Day Safety Report	SP830		2005-00843	115201

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03-Jan-06	0210		Initial Safety Report	SP774		2005-00834	122105
03-Jan-06	0210		Initial Safety Report	SP745		2005-00848	109209
09-Jan-06	0211		Follow-up Safety Report	SP830		2005-00821	110604
09-Jan-06	0212		Request FDA Comment	754, SP755, SPT	Submit proposed statistical analysis plan for protocol SP754 which may also apply to all double-blind trials in support of the treatment of epilepsy		
09-Jan-06	0213	v1	Information Amendment: Clinical	SP616	A multicenter, double-blind, double-dummy, randomized trial to investigate the safety, tolerability and pharmacokinetics of intravenous SPM 927 as replacement for oral SPM 927 in subjects with partial seizures with or without secondary generalization		
09-Jan-06	0213	v2	Information Amendment: Clinical	SP661	Randomized, double-blind, placebo-controlled, parallel-group, Phase 1 trial to evaluate the pharmacokinetics, safety, and tolerability following multiple-dose oral treatment of 200mg SPM 927 in healthy male White, Black, and Asian subjects		
09-Jan-06	0213	v2 p249	Information Amendment: Clinical	SP665	An open-label follow-on trial to assess the long-term safety and efficacy of oral SPM 927 in subjects with diabetic neuropathy		
13-Jan-06	0214		7-Day Safety Report	SP746		2005-00400	16304
16-Jan-06	0215		Follow-up Safety Report	SP640		2005-00636	82043

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16-Jan-06	0215		Follow-up Safety Report	SP745		2005-00848	109209
16-Jan-06	0215		Follow-up Safety Report	SP745		2005-00827	108112
17-Jan-06			7-Day Safety Report Fax	SP745		2006-00017	104902
17-Jan-06			General Correspondence	SP768	Email Ms. Calder, Ms. Griffis, and Ms. Malandro, FDA, notification that Schwartz will be submitting safety information		
17-Jan-06	0216		General Correspondence	SP768	Submit safety update		
17-Jan-06	0217		7-Day Safety Report	SP745		2005-00017	104902
18-Jan-06	0218		7-Day Safety Report	SP745		2006-00019	104910
20-Jan-06			General Correspondence	SP768	Email Ms. Malandro and Ms. Calder, FDA, outlier analysis for SP768 submitted 20-JAN-2006		
20-Jan-06			FDA Correspondence	SP768	Ms. Calder, FDA, confirms receipt of email containing outlier analysis for SP768		
20-Jan-06	0219		7-Day Safety Report	SP615		2005-00031	11522
20-Jan-06	0220		Protocol Amendment: New Investigator	SP767	New and revised investigators		
20-Jan-06	0221		General Correspondence	SP768	Submit outlier analysis of SP768		

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23-Jan-06			FDA Correspondence	754, SP755, SPt	Ms. Calder, FDA, emails comment from statistical team regarding proposed statistical analysis plan submitted 9-JAN-2006		
23-Jan-06	0222		General Correspondence	SP768	Submit IDMC data for 24-JAN-2006 teleconference (rescheduled to 27-JAN-2006 at 1:30pm)	2005-00370	12804/80207
24-Jan-06	0223		Follow-up Safety Report	SP754			
24-Jan-06	0223		Follow-up Safety Report	SP774		2005-00834	122105
01-Feb-06	0224		Response to FDA Request for Information	.SP746, SP830,	Submit minutes from IDMC closed session on 31-JAN-2006 and report how Schwarz is responding to IDMC's conclusions		
02-Feb-06			FDA Correspondence		Ms. Calder, FDA, emails that the Division may want to meet in the future but the medical team is still reviewing information submitted 1-FEB-2006		
02-Feb-06			General Correspondence		Email Ms. Calder, FDA, to ask if Division of Neurology Products is considering meeting over information provided 1-FEB-2006		
03-Feb-06			FDA Phone Contact		Ms. Calder, FDA, calls to notify of a 6-FEB-2006 teleconference from 3:00-4:00pm to discuss safety information for Iacosamide including the data submitted 17-JAN-2006 and 1-FEB-2006		
06-Feb-06			SB Meeting Minutes		SB draft meeting minutes from 06-FEB-2006 teleconference		

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06-Feb-06				General Correspondence		Email Ms. Calder, FDA, to confirm 6-FEB-2006 teleconference and confirm conference call number and conference code		
07-Feb-06	0225			Follow-up Safety Report	SP745		2005-00631	111607
07-Feb-06	0225			Follow-up Safety Report	SP774		2005-00834	122105
08-Feb-06				FDA Correspondence		Ms. Calder, FDA, emails report of delayed email		
10-Feb-06	0226			Information Amendment: Clinical	SP598, SP660			
10-Feb-06	0227			Initial Safety Report	SP774		2006-00074	2006-00074
10-Feb-06	0227			Initial Safety Report	SP746		2006-00056	14801
16-Feb-06	0228			Follow-up Safety Report	SP746		2005-00400	16304
16-Feb-06	0228			Follow-up Safety Report	SP774		2005-00834	122105
16-Feb-06	0228			Follow-up Safety Report	SP745		2006-00019	104910
17-Feb-06	0229			Request FDA Comment		Submit revised Informed Consent Form for review		
21-Feb-06	0230			Protocol Amendment: New Investigator	SP757	New and revised investigators		
23-Feb-06	0231			Follow-up Safety Report	SP768		2005-00556	106313/80468

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23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00750	104214/80312
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00744	108217/80452
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00375	109308/80117
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00089	112909/80024
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00424	101410/80256
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00119	110403/80108
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00545	108808/80185
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00533	103902/80631
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00544	114721/80494
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00096	112703/80093
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00444	112305/80382
23-Feb-06	0231		Follow-up Safety Report	SP768		2004-00790	112104/80001
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00358	108702/80471
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00061	111307/80163
23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00552	102704/80359

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23-Feb-06	0231		Follow-up Safety Report	SP768		2005-00634	104610/80545
	0231		Follow-up Safety Report	SP768		2005-00643	109138/80573
27-Feb-06	0232		7-Day Safety Report	SP830		2005-00644	105616
28-Feb-06	0233		7-Day Safety Report	SP745		2006-00114	106316
01-Mar-06	0234		Follow-up Safety Report	SP774		2006-00074	110405
01-Mar-06	0234		Follow-up Safety Report	SP774		2005-00803	110505/83749
01-Mar-06	0234		Follow-up Safety Report	SP745		2005-00597	111308
03-Mar-06	0235		General Correspondence		Request FDA review and comment on revised IB and ICF		
07-Mar-06			General Correspondence		Email Ms. Calder, FDA, about status of review of the IB and ICF for lacosamide		
08-Mar-06			FDA Correspondence		Ms. Calder, FDA, emails that she did not receive electronic copy of 03-MAR-2006 IB and ICF submission		
08-Mar-06			General Correspondence		Email Ms. Calder, FDA, first half of 03-MAR-2006 IB and ICF submission		
08-Mar-06			FDA Correspondence		Ms. Calder, FDA, emails successful receipt of electronic copy of 03-MAR-2006 IB and ICF submission		

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08-Mar-06			General Correspondence		CC Ms. Calder email copy of 03-MAR-2006 IB and ICF submission		
08-Mar-06			FDA Correspondence		Ms. Calder, FDA, emails that the Division has not yet seen 03-MAR-2006 IB and ICF submission		
08-Mar-06			General Correspondence		Email Ms. Calder, FDA, submission details for 03-MAR-2006 IB and ICF submission		
08-Mar-06			General Correspondence		Email Ms. Calder, FDA, second half of 03-MAR-2006 IB and ICF submission		
15-Mar-06	0236		Initial Safety Report	SP830		2006-00129	115104
15-Mar-06	0237		Follow-up Safety Report	SP774		2005-00803	110505/83749
15-Mar-06	0237		Follow-up Safety Report	SP746		2006-00056	14801
20-Mar-06	0238		Protocol Amendment: New Investigator	SP757	New investigators		
21-Mar-06	0239		Follow-up Safety Report	SP830		2005-00644	105616
29-Mar-06	0240		Information Amendment: Pharmacology/Toxicology	LPT 78604/02	6-Week subchronic toxicity study of SPM 927 by oral administration to juvenile CD® rats - age at start of administration: 7 days		
31-Mar-06			7-Day Safety Report Fax		Fax 31-Mar-2006 7-day safety report to Division		

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31-Mar-06	0241		7-Day Safety Report	SP757		2006-00158	170106
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00602	124609/88827
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00405	110109/83605
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00323	106406/82273
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00206	108202/82918
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00077	108401/82989
05-Apr-06	0242		Follow-up Safety Report	SP755		2005-00008	122303/87995
05-Apr-06	0242		Follow-up Safety Report	SP755		2004-00785	11601/85761
06-Apr-06	0243		7-Day Safety Report	SP757		2006-00166	170111
06-Apr-06	0244		Initial Safety Report	SP774		2006-00161	108404/8292
13-Apr-06	0245		Initial Safety Report	SP830		2006-00163	101109
14-Apr-06	0246		Meeting Request		Request Type B Pre-NDA meeting with Division of Neurology Products		
20-Apr-06	0247		Protocol Amendment: New Investigator	SP757	New investigators	2006-00114	106316
20-Apr-06	0248		Follow-up Safety Report	SP745			

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20-Apr-06	0248		Follow-up Safety Report	SP757		2006-00158	170106
20-Apr-06	0248		Follow-up Safety Report	SP757		2006-00166	170111
21-Apr-06	0249		General Correspondence		Submit cardiovascular analysis, as requested in 6-FEB-2006 teleconference with the division		
24-Apr-06			FDA Correspondence	SP757	Ms. Calder, FDA, emails to report subject number for adverse event report referenced in same-day email	2006-00158	170106
24-Apr-06			FDA Correspondence	SP757	Ms. Calder, FDA, emails questions about adverse event report and asks that Schwarz examine possible causality to medication and adequacy of cardiac monitoring during infusion	2006-00158	170106
25-Apr-06	0250		General Correspondence	40724/1	Submit rationale and draft protocols for juvenile dog studies for FDA review and comment		
25-Apr-06	0250		General Correspondence	40724/2	Submit rationale and draft protocols for juvenile dog studies for FDA review and comment		
26-Apr-06	0251		Initial Safety Report	SP774		2006-00066	124406
27-Apr-06	0252		Initial Safety Report	SP745		2005-00598	172207
27-Apr-06	0253		Follow-up Safety Report	SP774		2006-00161	103404/8292
27-Apr-06	0253		Follow-up Safety Report	SP830		2006-00163	101109

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28-Apr-06		General Correspondence	SP757	Email Ms. Calder, FDA, preliminary response to 24-APRIL-2006 email requesting additional safety information	2006-00158	170106	
01-May-06	0254	General Correspondence	SP757	Submit requested safety information	2006-00158	170106	
03-May-06		FDA Correspondence		Ms. Calder, FDA, emails additional request for suicidality data			
03-May-06	0255	Initial Safety Report	SP756		2006-00186	12202	
05-May-06	0256	Information Amendment: Clinical	SP641	Open, non-randomized, sequential group comparison to investigate the pharmacokinetics, safety, and tolerability of 100mg SPM 927 in m&f subj. with renal impairment incl. subj. requiring dialysis compared with m&f healthy subj. following single-dose admin.			
11-May-06	0257	General Correspondence		Submit narratives for cardiovascular analysis			
12-May-06		General Correspondence		Email Ms. Calder, FDA, to request status of the review of draft protocols submitted 25-APR-2006			
15-May-06		FDA Correspondence		Ms. Calder, FDA, emails that toxicology reviewer will not review 25-APR-2006 draft protocols for a few weeks			
15-May-06		General Correspondence		Email Ms. Calder, FDA, to ask if a toxicologist will be reviewing 25-APR-2006 draft protocols			

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15-May-06			FDA Correspondence		Ms. Calder, FDA, emails that the 25-APR-2006 draft protocols have not been reviewed yet but would be within the next week		
15-May-06			General Correspondence		Email Ms. Calder, FDA, to ask about status of draft toxicology studies		
15-May-06			FDA Correspondence		Ms. Calder, FDA, emails that the reviewer of IB hopes to have comments within the week		
15-May-06			General Correspondence		Email Ms. Calder, FDA, thanks for information on review timeline for 25-APR-2006 draft toxicology protocol submission		
18-May-06	0258		Initial Safety Report	SP774		2006-00032	110406
18-May-06	0258		Initial Safety Report	SP754		2006-00209	14312/80405
19-May-06	0259		Protocol Amendment: New Investigator	SP757	New and revised investigators		
22-May-06	0260		Follow-up Safety Report	SP754		2005-00775	12512/80299
22-May-06	0260		Follow-up Safety Report	SP830		2006-00129	115104
22-May-06	0260		Follow-up Safety Report	SP830		2005-00644	105616
22-May-06	0260		Follow-up Safety Report	SP745		2005-00598	172207

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26-May-06	0261		Information Amendment: Clinical	SP743	A multi-center, randomized, double-blind, placebo-controlled trial to assess the efficacy and safety of 400mg/day and 600mg/day SPM 927 in subjects with painful distal diabetic neuropathy		
26-May-06	0261		Information Amendment: Clinical	SP742	A multi-center, randomized, double-blind, placebo-controlled trial to assess the efficacy and safety of 200, 400, and 600mg/day SPM 927 in subjects with painful distal neuropathy		
30-May-06	0262		Protocol Amendment: Change in Protocol	SP756	Amendment 2		
30-May-06	0262		Protocol Amendment: Change in Protocol	SP754	Amendment 2		
30-May-06	0262		Protocol Amendment: Change in Protocol	SP615	Amendment 8		
01-Jun-06	0263		Follow-up Safety Report	SP774		2006-00032	110406
01-Jun-06	0263		Follow-up Safety Report	SP830		2006-00129	115104
02-Jun-06	0264		General Correspondence	SP755	Schwarz submits additional information requested by Calder, FDA, on 24-Apr-2006. Send revised narrative, cardiology consult reports and ECG reports	2006-00158	170106
16-Jun-06	0265		Meeting Package		Submit meeting package for 19-JUL-2006 Pre-NDA Meeting		
23-Jun-06	0266		Annual Report		Period covering March 26, 2005 through March 25, 2006		

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12-Jul-06	0267		Follow-up Safety Report	SP830		2006-00129	115104
18-Jul-06	0268		7-Day Safety Report	SP745		2006-00284	172723
18-Jul-06	0268		7-Day Safety Report	SP745		2006-00283	172719
20-Jul-06	0269		Protocol Amendment: New Investigator	SP767	Revised investigators		
25-Jul-06	0270		7-Day Safety Report	SP745		2006-00289	108305
31-Jul-06	0271		SB Meeting Minutes		Submit Pre-NDA Meeting Minutes from meeting held 19-JULY-2006		
02-Aug-06			General Correspondence		Mail to Dr. Levin, FDA, Type C meeting request with DNP, DAARP, and Office of Information Management to reach consensus with regard to technical aspects of filing lacosamide NDA		
02-Aug-06	0272		General Correspondence		Submit Type C meeting request with DNP, DAARP, and Office of Information Management to reach consensus with regard to technical aspects of filing lacosamide NDA		
07-Aug-06	0273		Initial Safety Report	SP756		2006-00295	18906
07-Aug-06	0273		Initial Safety Report	SP830		2006-00293	10118
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	A27033	SPM 927: Toxicity to activated sludge in a respiration inhibition test		

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10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	A22184	SPM 927: Toxicity to <i>scenedesmus subspicatus</i> in a 72-hour algal growth inhibition test		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	A22206	Adsorption/desorption of [14C]-SPM 927 on soils		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	F104017	Assessment of SPM 927 in the SOD1 transgenic mouse model of ALS		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	A22173	SPM 927: Ready biodegradability in a CO2 evolution (modified Sturm) test		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	F9696	Evaluation of SPM 927 and SPM 14221 in an animal model of fibromyalgia		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	RS211	Assessment of the dependence potential of SPM 927 in rats and dogs after chronic administration and abrupt withdrawal		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	F9664	Effects of SPM 927 (harkoseride) on the development of amygdala kindling in rats		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	03.488/5	Evaluation of lacosamide, lamotrigine, levetiracetam, pregabalin, amitriptyline and venlafaxine in a model of neuropathic pain (Chung) in the rat (i.p. administration)		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	10263	In vitro pharmacology – receptor binding assay with SPM 927 and SPM 12809		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	05.122/6	Evaluation of SPM 927 in the conditioned place preference test in the rat		

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10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	AA24877	Effects of SPM 927 (0.3, 1 and 3 mg/kg) on halothane-induced tremors in rats		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	E-006-05-04	Electrophysiological effects of SPM 12809 on the current mediated by the SCN5A-sodium channel stably expressed in CHO-K1 cells		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	732	Determination of the cytochrome P450 induction potential of lacosamide in human hepatocytes		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	LPT 18601/04	6-week dose-range-finding study for a 6-week subchronic toxicity study of SPM 927 by oral administration to juvenile CD® rats – age at start of administration: 7 days		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	LPT 18602/04	6-week subchronic toxicity study of SPM 927 by oral administration to juvenile CD® rats – age at start of administration: 7 days		
10-Aug-06	0274		Information Amendment: Pharmacology/Toxicology	JRO 217.27.275.	Neuroprotective effect of SPM 927 on traumatic brain injury in rat		
10-Aug-06	0275		Follow-up Safety Report	SP745		2005-00597	111308
16-Aug-06	0276		Follow-up Safety Report	SP774		2006-00161	108406/8292
21-Aug-06	0277		Protocol Amendment: New Investigator	SP757	Revised investigators		
22-Aug-06	0278		7-Day Safety Report	SP830		2006-00278	112204

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24-Aug-06	0279		Follow-up Safety Report	SP745		2006-00289	108305
24-Aug-06	0279		Follow-up Safety Report	SP756		2006-00295	18906
25-Aug-06	0280		Information Amendment: Clinical	SP658	Randomized, open-label, single-dose, 3-way crossover trial to compare the pharmacokinetics of SPM 927 when given as intravenous solution or as oral tablet in 24 healthy male subjects		
25-Aug-06	0280		Information Amendment: Clinical	SP863	Open-label multiple-dose trial to evaluate the pharmacokinetic effect of lacosamide on omeprazole and vice versa in healthy male White subjects		
25-Aug-06	0280		Information Amendment: Clinical	SP657	Randomized, open, 2-period crossover trial to show bioequivalence following single oral dosing of a tablet and of a liquid of 200mg SPM 927 each in healthy subjects		
25-Aug-06	0280		Information Amendment: Clinical	SP644	Double-blind, placebo-controlled, randomized crossover Phase I trial to investigate a possible influence of SPM 927 on the steady state pharmacokinetics, pharmacodynamics, safety and tolerability of digoxin in healthy male Caucasian subjects		
25-Aug-06	0280		Information Amendment: Clinical	SP643	Randomized, open-label, two-way crossover trial to investigate the pharmacokinetics and bioavailability of SPM 927 in poor and extensive metabolizers (CYP 2C19)		

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25-Aug-06	0280		Information Amendment: Clinical	SP599	A study of the potential pharmacodynamic and pharmacokinetic interaction of SPM 927 (harkoseneide) with Microgyn® in healthy female subjects		
28-Aug-06	0281		Request FDA Comment	SP903	Request comment on abuse liability plan		
01-Sep-06	0282		7-Day Safety Report	SP745		2006-00350	101802
01-Sep-06	0282		7-Day Safety Report	SP745		2006-00357	175702
01-Sep-06	0283		Information Amendment: Clinical		Submit Investigator's Brochure dated 29-AUG-2006		
06-Sep-06			SB Meeting Minutes		Schwarz internal summary of 06-OCT-2006 meeting with the FDA to discuss Iacosamide electronic submission issues		
07-Sep-06	0284		Follow-up Safety Report	SP774		2006-00161	108406/8292
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	Marzin-Lille	Expert report on the mutagenicity of SPM 927		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	LPT 17962/04	28-Day immunotoxicological study of SPM 927 by repeated oral administration to CD-1 mice – plaque forming colony (PFC) test		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	6842-103	Rising dose tolerance oral (capsule) toxicity study of ADD 234037 in dogs		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	LPT 17964/04	Acute toxicity study of SPM 927 by single oral administration to CD rats		

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12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	Oiney	Evaluation of the potential of SPM 927 to induce acute neurotoxic changes in the adult rat brain		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	S03311	An efficacy study of SPM 927 in a rat mammary tumor-induced bone pain model		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	SCHW 002	Evaluation of SPM 927 in an animal model for anxiety: stress-induced hyperthermia		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	00704	Therapeutic effect of SPM 927 in painful osteoarthritis in the rat		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	00649	Effect of SPM 927 in ddc-induced painful neuropathy in the rat		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	00580	Therapeutic effect of test compounds in painful diabetic neuropathy in the rat		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	00575	Effect of SPM 927 in vincristine-induced painful neuropathy in the rat		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	507/511	Effect of SPM 927 in two animal models of anxiety		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	505	Effect of SPM 927 in an animal model for mania		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	AA20234	Effects of SPM 927 on harmaline-induced tremors in rats		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	04.064/3	Evaluation of SPM 927 in a model of visceral pain in the rat		

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12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	LPT 17963/04	Acute toxicity study of SPM 927 by single intravenous administration to CD-1 mice		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	8540	In vitro pharmacology: GABA transaminase assay		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	SCHW001	Evaluation of SPM 927 alone and in combination with clozapine on the prepulse inhibition of the startle response in C56/BL6 mice		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	04.270/3	Evaluation of SPM 927 in the behavioral despair test in the rat (i.p. administration)		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	AA19072	Effects of SPM 927 on reserpine-induced tardive dyskinesia in mice		
12-Sep-06	0285		Information Amendment: Pharmacology/Toxicology	Krishna	Electrophysiological characterization of SPM-927		
15-Sep-06	0286		Initial Safety Report	SP774		2006-00366	104504
15-Sep-06	0287		Follow-up Safety Report	SP830		2006-00278	112204
15-Sep-06	0287		Follow-up Safety Report	SP745		2006-00357	175702
18-Sep-06			General Correspondence	SP903	Email Ms. Calder, FDA, to request she follow up with CSS about timeline for response to 28-AUG-2006 abuse liability protocol submission		
19-Sep-06			FDA Correspondence	SP903	Ms. Calder, FDA, emails that CSS has completed its review of the abuse liability protocol and will send comments soon		

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19-Sep-06			General Correspondence	SP903	Email Ms. Calder, FDA, thanks for following up with CSS on abuse liability protocol review		
20-Sep-06			General Correspondence	SP903	Email Ms. Calder, FDA, thanks for recommendations regarding the abuse liability protocol		
20-Sep-06			General Correspondence		Email Ms. Calder, FDA, for feedback on questions in cover letter of abuse liability submission		
20-Sep-06			FDA Correspondence	SP903	Ms. Calder, FDA, emails 'you're welcome' for recommendations regarding the abuse liability protocol		
20-Sep-06			FDA Correspondence	SP903	Ms. Calder, FDA, emails recommendations regarding the abuse liability protocol		
20-Sep-06	0288		Protocol Amendment: New Investigator	SP757	Revised investigator		
26-Sep-06	0289		7-Day Safety Report	SP745		2006-00389	170304
03-Oct-06			FDA Meeting Minutes		Ms. Calder, FDA, emails meeting minutes from 06-SEP-2006 meeting to discuss the electronic submission of multiple NDAs with multiple indications		
10-Oct-06	0290		Follow-up Safety Report	SP745		2006-00389	170304
16-Oct-06	0291		Initial Safety Report	SP874		2006-00403	125009/80029

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16-Oct-06	0292		7-Day Safety Report	SP745		2005-00509	171324
19-Oct-06	0293		Initial Safety Report	SP774		2006-00409	122402
19-Oct-06	0294		Follow-up Safety Report	SP754		2005-00370	12804/80207
23-Oct-06	0295		7-Day Safety Report	SP830		2006-00420	105309
23-Oct-06	0296		General Correspondence	SP903	Submit Protocol SP903 integrating comments from CSS	2006-00418	124701/80223
25-Oct-06	0297		7-Day Safety Report	SP874			
26-Oct-06	0298		Follow-up Safety Report	SP745		2006-00350	101802
26-Oct-06	0299		Information Amendment: Clinical	SP755	A multicenter, double-blind, randomized, placebo-controlled, parallel-group trial to investigate the efficacy and safety of SPM 927 (200 and 400mg/day) as adjunctive therapy in subjects with partial seizures with or without secondary generalization		
02-Nov-06	0300		Initial Safety Report	SP774		2006-00094	114109
02-Nov-06	0301		Follow-up Safety Report	SP774		2006-00409	122402
02-Nov-06	0301		Follow-up Safety Report	SP754		2006-00209	14312/80405
07-Nov-06	0302		Follow-up Safety Report	SP830		2006-00420	105309

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09-Nov-06	0303		Follow-up Safety Report	SP830		2006-00278	112204
13-Nov-06	0304		Follow-up Safety Report	SP830		2006-00129	115104
13-Nov-06	0304		Follow-up Safety Report	SP874		2006-00418	124701/80223
15-Nov-06	0305		Follow-up Safety Report	SP830		2006-00438	105318
28-Nov-06	0306		Follow-up Safety Report	SP830		2006-00438	105318
28-Nov-06	0306		Follow-up Safety Report	SP874		2006-00403	125009/80029
28-Nov-06	0306		Follow-up Safety Report	SP874		2006-00418	124701/80223
05-Dec-06	0307		7-Day Safety Report	SP874		2006-00472	102205/80148
05-Dec-06	0308		SB Meeting Minutes		Submit minutes from 15-NOV-2006 Type A meeting		
06-Dec-06	0309		General Correspondence		Submit IDMC correspondence wherein IDMC informs Schwarz that lacosamide up to 600mg can be allowed in trials of subjects with diabetic peripheral neuropathy		
11-Dec-06	0310		7-Day Safety Report	SP874		2006-00478	129704/80308
19-Dec-06	0311		Initial Safety Report	SP830		2006-00495	114006
19-Dec-06	0312		Follow-up Safety Report	SP874		2006-00478	129704/80308

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20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	A45202	SPM 927: Effect on survival and reproduction of <i>Daphnia magna</i> in a semi-static test over three weeks		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	A45180	SPM 927: Toxic effects to zebra fish ( <i>Brachydanio rerio</i> ) in an early-life stage toxicity test		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	699/17	(14C)-SPM 927: Quantitative whole-body autoradiography following oral and intravenous administration to the pigmented rat		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	8540	In Vitro Pharmacology: GABA Transaminase Assay – Study of SPM 927		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	847	Structure proposal for polar metabolite		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	826	SPM 927: Metabolite profiling and identification in the mouse, rat and dog		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	699/48	A study of absorption, distribution, metabolism and excretion following oral and intravenous administration to the dog		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	699/46	A study of absorption, distribution, metabolism and excretion following oral administration to the mouse		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	699/47	SPM 927: A study of absorption and excretion following oral administration to the rat		

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20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology	Drommer		SPM 927 Light and electron microscopical investigation of liver tissues from study "13-week oral gavage subchronic toxicity of ADD 234037 in rats"		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology		F9672	Evaluation of the neuroprotective efficacy of compound SPM 927 in rat hippocampal slice cultures after OGD, glutamate and staurosporine insult		
20-Dec-06	0313		Information Amendment: Pharmacology/Toxicology		865	Inhibition of the cytochrome P450 isoenzymes 1A1, 2A6, 2B6, 2C8, 2E1 and 3A5 by SPM 927 and SPM 12809	2006-00481	112315
21-Dec-06	0314		Initial Safety Report		SP774			
22-Dec-06	0315		Initial Safety Report		SP874		2006-00488	115902/80260
22-Dec-06	0316		Follow-up Safety Report		SP874		2006-00472	102205/80148
03-Jan-07	0317		Initial Safety Report		SP745		2006-00510	110718
03-Jan-07	0317		Initial Safety Report		SP615		2006-00515	101911
03-Jan-07	0318		Follow-up Safety Report		SP745		2006-00289	108305
03-Jan-07	0319		7-Day Safety Report		SP756		2006-00473	156016
17-Jan-07	0320		Initial Safety Report		SP774		2007-00013	116206
17-Jan-07	0321		Follow-up Safety Report		SP874		2006-00488	115902/80260

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17-Jan-07	0321		Follow-up Safety Report	SP830		2006-00495	114006
17-Jan-07	0322		7-Day Safety Report	SP874		2007-00020	129506/80472
17-Jan-07	0322		7-Day Safety Report	SP874		2007-00023	115702/80415
24-Jan-07	0323		Information Amendment: Pharmacology/Toxicology	031209	Identification of hankoseride (SPM 927) targets using affinity capture and proteomics technologies		
24-Jan-07	0323		Information Amendment: Clinical	SP757	A multicenter, open-label trial to investigate the safety and tolerability of intravenous SPM 927 as replacement for oral SPM 927 in subjects with partial seizures with or without secondary generalization	2007-00023	115702/80415
30-Jan-07	0324		Follow-up Safety Report	SP874		2006-00510	110718
30-Jan-07	0324		Follow-up Safety Report	SP745		2006-00464	126603/80275
30-Jan-07	0325		7-Day Safety Report	SP874		2007-00029	116205
08-Feb-07	0326		Initial Safety Report	SP774		2007-00055	175516
12-Feb-07	0327		7-Day Safety Report	SP745		2007-00048	100806
12-Feb-07	0327		7-Day Safety Report	SP745		2006-00464	126603/80275
12-Feb-07	0328		Follow-up Safety Report	SP874			

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Type</i>	<i>Submission</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
12-Feb-07	0328		Follow-up Safety Report	SP615			2006-00515	2006-00515
20-Feb-07	0329		7-Day Safety Report	SP746			2007-00068	102802
20-Feb-07	0330		Initial Safety Report	SP745			2007-00061	108703
20-Feb-07	0330		Initial Safety Report	SP746			2007-00066	125012
20-Feb-07	0331		Follow-up Safety Report	SP874			2007-00020	129506/80472
23-Feb-07	0332		7-Day Safety Report	SP745			2007-00076	170801
23-Feb-07	0332		7-Day Safety Report	SP830			2007-00074	116001
23-Feb-07	0332		7-Day Safety Report	SP746			2007-00056	110804/80106
23-Feb-07	0333		Follow-up Safety Report	SP874			2006-00464	126603/80275
27-Feb-07	0334		Follow-up Safety Report	SP615			2003-00367	11776
27-Feb-07	0334		Follow-up Safety Report	SP746			2007-00068	102802
05-Mar-07	0335		Follow-up Safety Report	SP830			2007-00074	116001
12-Mar-07	0336		7-Day Safety Report	SP874			2007-00088	121012/80641

<i><b>Submission Date</b></i>	<i><b>Serial No</b></i>	<i><b>Location</b></i>	<i><b>Submission Type</b></i>	<i><b>Study No</b></i>	<i><b>Title/ Description</b></i>	<i><b>CIOMS Mfr Control No</b></i>	<i><b>CIOMS Subject No</b></i>
14-Mar-07	0337		Information Amendment: Clinical	SP640	A double-blind, single-site, randomized, placebo- and positive-controlled, parallel-design trial of the electrocardiographic effects of 400 and 800mg per day of lacosamide in healthy male and female subjects: a thorough QT trial		
19-Mar-07	0338		General Correspondence		Request comment on plan to submit integrated safety datasets for all patients in phase 2b/3 trials		
20-Mar-07	0339		Initial Safety Report	SP774		2006-00319	124611
20-Mar-07	0340		Follow-up Safety Report	SP830		2006-00420	105309
20-Mar-07	0340		Follow-up Safety Report	SP874		2006-00488	115902/80260
23-Mar-07	0341		General Correspondence	SP906	Updated cardiovascular safety report		
26-Mar-07	0342		7-Day Safety Report	SP874		2007-00100	101408/80363
26-Mar-07	0343		Follow-up Safety Report	SP746		2007-00066	125012
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	1S-4-2311 Adden	Addendum to the study report: the early evaluation of anticonvulsant drugs		
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	05.673/4	Evaluation of SPM 927 for abuse potential using an i.v. self-administration paradigm in the rat		
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	C13703	The effects of lacosamide in an animal model for migraine		

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Type</i>	<i>Study No</i>	<i>Title/Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	Morrow	Harkosentide in pre-clinical animal models of pain		
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	05.264/2	Pseudo-isobolographic evaluation in combination with 5 other analgesic substances using the formalin (late phase) test in the rat (i.p. administration)		
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	05.237/5	Evaluation of SPM 927 as a discriminative stimulus in a drug discrimination procedure in the rat		
04-Apr-07	0344		Information Amendment: Pharmacology/Toxicology	/B-PDG-2006-521	UV/VIS-absorption of O-desmethyl-lacosamide (SPM 12809)	2007-00088	121012/80641
13-Apr-07	0345		Follow-up Safety Report	SP874			
13-Apr-07	0345		Follow-up Safety Report	SP745		2007-00061	108703
17-Apr-07	0346		Response to FDA Request for Information	SP640	Submit SP640 data in response to 22-MARCH-2007 email request from Malandro		
23-Apr-07			7-Day Safety Report Fax	SP745		2005-00835	174203
23-Apr-07	0347		7-Day Safety Report	SP745		2005-00835	174203
23-Apr-07	0348		Initial Safety Report	SP756		2006-00422	17407
23-Apr-07	0349		Follow-up Safety Report	SP615		2003-00367	11776

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
24-Apr-07	0350		Information Amendment: Clinical	SP754	A multicenter, double-blind, randomized, placebo-controlled, parallel-group trial to investigate the efficacy and safety of SPM 927 (400 and 600 mg/day) as adjunctive therapy in subjects with partial seizures with or without secondary generalization	2006-00098	115110
27-Apr-07	0351		Safety Report Fax	SP830			
27-Apr-07	0351		7-Day Safety Report	SP830		2006-00098	115110
03-May-07	0352		Follow-up Safety Report	SP874		2007-00100	101408/80363
09-May-07	0353		Initial Safety Report	SP756		2007-00140	14308
09-May-07	0354		Follow-up Safety Report	SP830		2006-00098	115110
09-May-07	0354		Follow-up Safety Report	SP745		2006-00510	110718
09-May-07	0355		Information Amendment: Pharmacology/Toxicology	977	Metabolite turnover of SPM 927, SPM 6912 and SPM 12809 in S9 fractions obtained from male rat and human livers		
09-May-07	0355		Information Amendment: Pharmacology/Toxicology	1000	Profiling of polar metabolite		
16-May-07	0356		Request FDA Comment	raft, LPT 20614/K	Request for FDA review and comment and teleconference to discuss Division's response		
17-May-07	0357		General Correspondence	SP754, SP756	Submit follow up information in response to 04-MAY-2007 email from Lana Chen, FDA	000#5#2006-00422	17407

<i>Submission Date</i>	<i>Serial No</i>	<i>Location</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title/ Description</i>	<i>CIOMS Mfr Control No</i>	<i>CIOMS Subject No</i>
21-May-07			7-Day Safety Report Fax	SP745		2005-00463	176213
21-May-07	0358		7-Day Safety Report	SP745		2005-00463	176213
21-May-07	0359		Follow-up Safety Report	SP745		2006-00510	110718
22-May-07	0360		Follow-up Safety Report	SP756		2006-00442	17407
07-Jun-07	0361		7-Day Safety Report	SP745		2007-00155	109133
21-Jun-07			General Correspondence		Email Ms. Griffis, FDA, plan to submit one all-inclusive NDA under one NDA number		
22-Jun-07	0362		Initial Safety Report	SP874		2007-00119	124413/80424
25-Jun-07	0363		Annual Report		For the period 26-MAR-2006 through 25-MAR-2007		
27-Jun-07	0364		Information Amendment: Clinical	SP746 subtrial	A double-blind, randomized withdrawal of Iacosamide in subjects with painful diabetic neuropathy - subtrial to SP746		
06-Jul-07	0365		7-Day Safety Report	SP746		2007-00199	124902
06-Jul-07	0366		Initial Safety Report	SP774		2007-00201	106404
06-Jul-07	0367		General Correspondence				
12-Jul-07	0368		Initial Safety Report	SP746		2007-00203	101208

<i><b>Submission Date</b></i>	<i><b>Serial No</b></i>	<i><b>Location</b></i>	<i><b>Submission Type</b></i>	<i><b>Study No</b></i>	<i><b>Title/ Description</b></i>	<i><b>CIOMS Mfr Control No</b></i>	<i><b>CIOMS Subject No</b></i>
13-Jul-07			FDA Phone Contact		Discuss proposed schematic of NDAtCTD organization and obtain updated status of juvenile toxicology protocol review		
19-Jul-07	0369		7-Day Safety Report	SP746		2007-00214	105622
20-Jul-07	0370		Response to FDA Request for Information		Submit additional information request by Ms. Griffis regarding proposed trade name submission		
23-Jul-07			FDA Phone Contact		Ms. Griffis, FDA, called on behalf of DMETS to request additional information on trade name review submission		
23-Jul-07			FDA Correspondence		Ms. Griffis, FDA, emails comments from nonclinical team regarding draft protocol for juvenile dog toxicity study		
30-Jul-07	0371		7-Day Safety Report	SP830		2007-00230	105806
30-Jul-07	0372		Follow-up Safety Report	SP745		2005-00835	174203
06-Aug-07	0373		Follow-up Safety Report	SP830		2007-00074	116001
08-Aug-07	0374		Initial Safety Report	SP746		2007-00231	118301
14-Aug-07	0375		7-Day Safety Report	SP815		2005-00465	10477
15-Aug-07	0376		7-Day Safety Report	SP746		2007-00244	102717
15-Aug-07	0376		7-Day Safety Report	SP830		2007-00248	114211

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15-Aug-07	0376		7-Day Safety Report	SP745		2007-00246	110907
20-Aug-07	0377		7-Day Safety Report	SP830		2005-00618	105019
21-Aug-07	0378		Initial Safety Report	SP774		2006-00066	124406
21-Aug-07	0379		Follow-up Safety Report	SP746		2007-00231	118301
21-Aug-07	0379		Follow-up Safety Report	SP746		2007-00199	124902
23-Aug-07	0380		Information Amendment: Clinical	SP903	Single-site, randomized, double-blind, placebo- and active comparator controlled single-dose crossover trial to evaluate the abuse potential of lacosamide in healthy subjects with a history of recreationally CNS depressant use		
27-Aug-07	0381		Follow-up Safety Report	SP746		2007-00199	124902
27-Aug-07	0381		Follow-up Safety Report	SP746		2007-00244	102717
27-Aug-07	0381		Follow-up Safety Report	SP830		2007-00248	114211
28-Aug-07	0382		7-Day Safety Report	SP745		2007-00255	108222
04-Sep-07	0383		Follow-up Safety Report	SP746		2007-00203	101208
07-Sep-07	0384		7-Day Safety Report	SP745		2007-00265	102202
07-Sep-07	0385		Follow-up Safety Report	SP830		2007-00248	114211

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07-Sep-07	0385		Follow-up Safety Report	SP830			2007-00248	105019
12-Sep-07	0386		Follow-up Safety Report	SP746			2007-00214	105622
12-Sep-07	0386		Follow-up Safety Report	SP830			2007-00248	114211
12-Sep-07	0386		Follow-up Safety Report	SP615			2005-00465	10477
04-Oct-07	0387		Initial Safety Report	SP746			2007-00281	101707
15-Oct-07	0388		7-Day Safety Report	SP615			2007-00289	10180
16-Oct-07	0389		Initial Safety Report	SP756			2007-00295	15405
19-Oct-07	0390		Initial Safety Report	SP745			2007-00288	114721
19-Oct-07	0391		Information Amendment: Clinical			Investigator's Brochure dated 31-AUG-2007		
25-Oct-07	0392		Initial Safety Report	SP615			2007-00292	11429
30-Oct-07	0393		Follow-up Safety Report	SP756			2007-00295	15405
01-Nov-07	0394		7-Day Safety Report	SP746			2007-00308	105621
01-Nov-07	0395		Initial Safety Report	SP774			2006-00439	100804
12-Nov-07	0396		Initial Safety Report	10053			2007-00316	SP615

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14-Nov-07	0397		Initial Safety Report			2007-00317	101904
15-Nov-07	0398		General Correspondence		Appointment of UCB as agent in safety reporting to the IND		
04-Dec-07	0401		Follow-up Safety Report			2007-00316	10053
04-Dec-07	0402		Follow-up Safety Report			2007-00288	114721
05-Dec-07	0403		Protocol Amendment: New Protocol	SP925	Original Protocol		
20-Dec-07	0407		General Correspondence	LPT 20615	Request FDA concurrence on proposed dosing increase		
28-Feb-08					Email Ms. Ware, FDA, proposed language for updating Informed Consent based on the FDA Alert for suicidality and antiepileptic drugs		
20-Mar-08	04117		Protocol Amendment: New Investigator	SP925	New investigator		
01-Apr-08			General Correspondence		Email Ware that revised Informed Consent language will be distributed to all lacosamide INDs		
01-Apr-08			FDA Correspondence		Ware emails Division's response to proposed Informed Consent language		
20-May-08	0420		Protocol Amendment: New Investigator	SP925	New investigators		

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28-May-08	0422		Information Amendment: Pharmacology/Toxicology	F-9945	Differential block of sensory neuronal voltage-gated sodium channels by lacosamide, lidocaine and carbamazepine. (Previously: Effect of lacosamide on recombinant Nav 1.3 and Nav 1.7 voltage-gated sodium current properties)		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	LPT 20614/06	6-Week Dose-Range-Finding Study for a 33-Week Chronic Toxicity Study of SPM 927 by Repeated Oral Administration to Juvenile Beagle Dogs		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	0699/069	(14C)-SPM 927: A study of absorption and excretion following single oral administration to the rabbit		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	847 Amend 1	Structure proposal for polar metabolite		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	9496	Oxford Cardiac Pharmacology Ltd: Effect of lacosamide on action potential parameters (including V <sub>max</sub> , the maximal rate of rise) in guinea pig ventricular myocytes		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	MD-11-011-0012	Evaluation of potential effect of Lacosamide in the acute experimental allergic encephalomyelitis rat model		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	F-9938	Effect of lacosamide on slow inactivation in Nav 1.2 (expressed in CHO cells) Nav 1.4 and Nav 1.4 and Nav 1.4/IFM>CoQ (expressed in Xenopus oocytes)		

<i><b>Submission Date</b></i>	<i><b>Serial No</b></i>	<i><b>Location</b></i>	<i><b>Submission Type</b></i>	<i><b>Study No</b></i>	<i><b>Title/ Description</b></i>	<i><b>CIOMS Mfr Control No</b></i>	<i><b>CIOMS Subject No</b></i>
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	SCHW 004	Evaluation of Lacosamide in an animal model for obsessive compulsive disorder: marble burying		
28-May-08	0422		Information Amendment: Pharmacology/Toxicology	F-9928	Determination of interaction of Lacosamide with the antiepileptic drugs carbamazepine, Phenytoin, sodium valproate, lamotrigine, levetiracetam, topiramate and gabapentin		
24-Jun-08	0424		Annual Report		Period covering March 26, 2007 through March 25, 2008		
20-Aug-08	0425		Protocol Amendment: New Investigator	SP925	New investigators		
09-Oct-08	0431		Protocol Amendment: Change in Protocol	SP925	Amendment 1		

# NDA 22-254 Submissions

Date	Serial No	Submission Type	Study No	Title of Report
28-Sep-07	0000	Original NDA		
20-Nov-07		FDA Correspondence		
26-Nov-07	0001	Response to FDA Request for Inf		Ms. Ware, FDA, emails request from clinical pharmacology group related to initial filing review of the lacosamide applications
10-Dec-07		FDA Correspondence		Submit response to 20-NOV-2007 clinical pharmacology request
13-Dec-07		Amendment to a Pending Application		Dr. Katz, FDA, sends letter accepting NDA for filing
13-Dec-07	0002	Amendment to a Pending Application		Submit additional clinical pharmacology responses
19-Dec-07		General Correspondence		Response to request: clinical pharmacology; provide responses not included in 0001
07-Jan-08		FDA Correspondence		Email Ms. Ware, FDA, preliminary responses to 74-day letter
07-Jan-08		General Correspondence		Ms. Ware, FDA, emails request from clinical and statistical team for additional datasets
14-Jan-08		FDA Correspondence		Email Ms. Ware, FDA, that requested datasets were sent on DVD via courier
15-Jan-08		General Correspondence		Ms. Ware, FDA, emails requests from DNP's clinical team related to ongoing review of lacosamide applications
15-Jan-08		FDA Correspondence		Email Ms. Ware, FDA, for additional explanation on clinical questions received 14-JAN-2008
16-Jan-08		General Correspondence		Ms. Ware, FDA, emails information request related to 14-JAN-2008 FDA email
16-Jan-08		FDA Correspondence		Email Ms. Ware, FDA, summary of 16-JAN-2008 conversation discussing GCP inspections
17-Jan-08		FDA Correspondence		Mr. Sullivan, FDA, emails outstanding clinical pharmacology items
23-Jan-08	0003	Amendment to a Pending Application		Ms. Gunther, FDA, emails information request for potential inspection sites
29-Jan-08		FDA Correspondence		120-day safety update and 74-day letter responses
				Ware emails request from DNP's clinical team for a summary table of AE that led to dose reduction and/or discontinuation by SOC and PT in Pool EP S1 by dose at onset

<i>Date</i>	<i>Serial No</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title of Report</i>
31-Jan-08		FDA Correspondence		Ms. Ware, FDA, emails request from DNP's clinical team
04-Feb-08		FDA Correspondence		Ms. Mercado, FDA, emails request for confirmation for FDA inspection of NDA 22-254 in Germany
06-Feb-08		FDA Correspondence	SP742, SP743, SP768	Sullivan emails request additional analyses for SP742, SP743, and SP768
07-Feb-08		FDA Correspondence		Sheryl Gunther, FDA, emails request for addresses for investigators Nischik, Pojarkovic, and Hajnsek
08-Feb-08		General Correspondence		Email Ms. Gunther, FDA, contact information requested 07-FEB-2008
08-Feb-08		FDA Correspondence		Ms. Gunther, FDA, emails thanks for contact information
08-Feb-08		General Correspondence		Email Ms. Ware, FDA, partial responses to questions received 14-JAN-2008 and 31-JAN-2008
08-Feb-08		Response to FDA Request for Inf		Send Ms. Gunther, FDA, background investigator information requested 17-JAN-2008
12-Feb-08		General Correspondence		Email Ms. Ware, FDA, additional partial responses to questions received 14-JAN-2008 and 31-JAN-2008
13-Feb-08	0004	Amendment to a Pending Application		Response to request: clinical; respond to questions received 15-JAN, 29-JAN, and 31-JAN-2008
14-Feb-08		FDA Correspondence		Ms. Ware, FDA, emails requests from DNP's clinical team
14-Feb-08		General Correspondence		Email Ms. Ware, FDA, that one request from 14-FEB-2008 email is addressed in lifecycle received today and the other will be reviewed
22-Feb-08		General Correspondence		Email Ms. Ware, FDA, responses to request from 14-FEB-2008 email
25-Feb-08	0005	Amendment to a Pending Application		Response to request: clinical; respond to 31-JAN-2008, 06-FEB-2008, and 14-FEB-2008 email requests
26-Feb-08		FDA Correspondence		Ms. Ware emails request from DNP's clinical pharmacology team
03-Mar-08		FDA Correspondence		Ms. Ware, FDA, emails requests from DNP's clinical team
05-Mar-08		FDA Correspondence		Email Ms. Ware, FDA, response to one of the request received 03-MAR-2008
05-Mar-08		General Correspondence		Email Ms. Ware, FDA, response to request received 26-FEB-2008

Date	Serial No	Submission Type	Study No	Title of Report
06-Mar-08		FDA Correspondence		Sullivan emails request from DAARP team for narratives for all patients with AEs of syncope of presyncope and tables comparing frequency of event by treatment group
07-Mar-08		FDA Correspondence	SP754	Ware emails requests from DNP's clinical team; request additional detail on subject 75411401 and clarification of footnote in cardiac report
07-Mar-08		FDA Phone Contact		Discuss NDA reviews with Ms. Ware, FDA
10-Mar-08		General Correspondence		Email Ms. Ware, FDA, clarification on 03-MAR-2008 request
10-Mar-08		Response to FDA Request for Inf		Submit requested ECG data for subjects in EP Pool S1
11-Mar-08		FDA Correspondence		Mr. Sullivan emails on behalf of Ms. Ware request for additional analyses
11-Mar-08		General Correspondence		Email Dr. Vallalba and Ms. Ware password for response to request for EP pool S1 dataset from ISS
11-Mar-08		General Correspondence		Request Ms. Ware forward 11-MAR-2008 email to Dr. Vallalba
13-Mar-08		FDA Correspondence	SP903	Sullivan emails request from the stats reviewer for clarification on abuse liability study's dataset
20-Mar-08	0006	Amendment to a Pending Application		Response to Request: Clinical: respond to 04-MAR-2008 teleconference request and 13-MAR-2008 email; also respond to email requests 26-FEB-2008, 03-MAR-2008, 07-MAR-2008, 11-MAR-2008; provide draft blister labels and cartons requested in 74-day letter
20-Mar-08		FDA Correspondence		Sullivan emails CMC IR letter that applies to drug substance, tablet, and IV drug product
20-Mar-08		FDA Correspondence		Dr. Sood, FDA, mails information request letter regarding drug substance and drug product
31-Mar-08		FDA Correspondence		Sullivan emails request to resubmit ISS lab1.xpt and lab2.xpt datasets as separate files
02-Apr-08		FDA Correspondence		Ware emails requests from DNP's statistical team
03-Apr-08		FDA Correspondence		Ware emails requests from DNP's statistical team
03-Apr-08	0007	Amendment to a Pending Application		Response to Request: Clinical: respond to 07-MAR-2008 email request for clarification on subject 75411401 and 31-MAR-2008 email request for lab datasets
04-Apr-08		General Correspondence		Email Ware receipt of 04-APR-2008 comments regarding impurity specifications
04-Apr-08		General Correspondence		Email Ware agreement to be available 07-APR-2008 between 1pm and 3pm to discuss internal FDA meeting

Date	Serial No	Submission Type	Study No	Title of Report
04-Apr-08		FDA Correspondence		Ware emails that labelling submission next week is acceptable; would like to speak about updates from internal meeting
04-Apr-08		FDA Correspondence		Ware adds additional comment to email sent earlier today
04-Apr-08		FDA Correspondence		Ware emails comments from ONDQA and OND non-clinical review teams related to proposed impurity specifications
04-Apr-08		General Correspondence		Email Ware if there is any update regarding CSS and the tradename and notify that revised label/container cartons will be sent next week
07-Apr-08		FDA Correspondence		Ware emails agreement to clarification on symbol in 04-APR-2008 request
07-Apr-08		General Correspondence		Email Ware clarification on symbol in 04-APR-2008 request
09-Apr-08	0008	Amendment to a Pending Application		Revised labeling - excluding package insert
11-Apr-08		General Correspondence		Email Ware responses to 02-APR-2008 statistical questions
11-Apr-08		General Correspondence		Email Ware responses to questions emailed 04-APR-2008 on drug substance and IV/syrup formulation
14-Apr-08	0009	Amendment to a Pending Application		Response to Request: Clinical; respond to 06-MAR-2008 and 07-MAR-2008 clinical email requests for narratives for all neuropathic pain subjects with syncopae or presyncope; provide narratives for migraine study dropouts as requested in 11-MAR-2007 email
16-Apr-08		FDA Correspondence		Ware emails request from DNP's clinical team regarding overall exposure to lacosamide and placebo in all studies
18-Apr-08		Amendment to a Pending Application		Provide responses to requests in CMC letter dated 20-MAR-2008 and emails dated 02-APR-2008 and 04-APR-2008
18-Apr-08		FDA Correspondence	SP755, SP774, SP757	Ware emails request from DNP's clinical team regarding patients 170106 and 17011
18-Apr-08	0010	Amendment to a Pending Application		Respond to 20-MAR-2008 CMC request and 02-APR-2008 and 04-APR-2008 email requests
25-Apr-08		FDA Correspondence		Ware emails request from DNP's CMC review team
25-Apr-08		FDA Correspondence		Ware emails request from DNP's clinical team regarding subject 588/8061
28-Apr-08		General Correspondence		Email Ware Schwarz commitments following 23-APRIL-2008 teleconference regarding oral syrup dosing

<i>Date</i>	<i>Serial No</i>	<i>Submission Type</i>	<i>Study No</i>	<i>Title of Report</i>
29-Apr-08		FDA Correspondence		Sullivan emails request for narratives of patients with AE dyskinesia
30-Apr-08	0011	Amendment to a Pending Applicat		Respond to requests received 20-MAR-2008, 16-APR-2008, and 18-APR-2008
30-Apr-08		Response to FDA Request for Inf	1106	Email Ware partial response to 25-APRIL-2008 email request regarding CMC data
06-May-08		FDA Correspondence		Sullivan emails request from reviewer of Environmental Assessment to submit a non-confidential EA
07-May-08		FDA Correspondence		Ware emails request from DNP's clinical team requesting narratives and CRFs for four patients who discontinued due to cardiac or ECG issues; ECGs for 754122303; suicidality information on 75412512
08-May-08		Response to FDA Request for Inf		Email Ware dyskinesia narratives requested in 29-APRIL-2008 email
09-May-08	0012	Amendment to a Pending Applicat		Response to requests; respond to nonclinical question in 25-APR-2008 email and provide revision to environmental assessment requested in 06-MAY-2008 email
12-May-08		FDA Correspondence		Ware emails requests from DNP's clinical team
12-May-08		General Correspondence		Email Ware that 12-MAY-2008 requests have been received
12-May-08		FDA Correspondence		Ware emails request from chemistry review team regarding NDA 22-254 and NDA 22-255
13-May-08		Response to FDA Request for Inf		Email Ware AE report responding to 25-APRIL-2008 email request regarding subject 588-8061
13-May-08		General Correspondence		Email Ware requested laboratory results for subject 588/5061
16-May-08		Response to FDA Request for Inf		Email Ware response to questions 2, 3, and 4 from 12-MAY-2008 email request
16-May-08		Response to FDA Request for Inf		Email Ware responses to bullets 1 and 2 from 07-MAY-2008 email request regarding narratives and CRFs and ECG data
16-May-08		General Correspondence		Email Ware question/proposal regarding request number 5 from 12-MAY-2008 email request
16-May-08		FDA Correspondence		Ware emails request from clinical reviewer for clarification on tables EP 5.1.1 and EP 5.1.2 from partial response to 12-MAY-2008 request
19-May-08		Response to FDA Request for Inf		Email Ware partial response to 16-MAY-2008 email request and suggest teleconference if response is not sufficient
19-May-08		Response to FDA Request for Inf		Email Ware response to bullet 3 from 07-MAY-2008 email request regarding subject 75412512 suicidality

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20-May-08		FDA Correspondence	SP643	Ware emails requests from clinical pharmacology review team regarding SP643 and analytical assay validation methods
21-May-08		FDA Correspondence		Ware emails WORD document of example table for requested summary information on analytical assay validation methods
22-May-08		FDA Correspondence		Ware emails request from clinical review team for additional information on subject 588/8061
23-May-08		General Correspondence		Email Ware response to 22-MAY-2008 request for information on subject 588/5061
23-May-08		Response to FDA Request for Inf		Email Ware response to email request received 22-MAY-2008 regarding subject 588/8061
27-May-08		Response to FDA Request for Inf	SP643	Email Ware responses to clinical pharmacology requests received in 20-MAY-2008 email regarding subject classification in SP643 and analytical assay validation methods
27-May-08	0013	Amendment to a Pending Application		Response to requests in 25-APR-2008, 29-APR-2008, 07-MAY-2008, 12-MAY-2008, 16-MAY-2008, and 22-MAY-2008 emails
30-May-08		FDA Phone Contact		Ware calls to request WORD copy of draft labeling; also discuss review items: scheduling, labels, post-marketing requests, REMS, pediatrics, class labeling
02-Jun-08		FDA Correspondence		Ware emails question about 02-JUNE-2008 response to 12-MAY-2008 question 1
04-Jun-08		General Correspondence		Email Ware concomitant disease tables requested 12-MAY-2008
06-Jun-08		FDA Correspondence		Ware emails request for teleconference 12-JUNE-2008 at 10:15 to discuss potential cases of multi-organ hypersensitivity
11-Jun-08	0014	Amendment to a Pending Application		Respond to requests received 12-MAY-2008 and 2-JUN-2008
11-Jun-08		FDA Correspondence	SP830	Ware emails request for additional information on subject SP830/111201 and request for database search for all cases of potential multiorgan hypersensitivity reactions
26-Jun-08		FDA Phone Contact		Ware calls to discuss review with goal of reaching an actio by 29-JUL-2008, dependent on review of multi-organ hypersensitivity data; also discuss labeling
30-Jun-08		Meeting Request		Type A meeting request to discuss abuse potential of lacosamide
02-Jul-08		FDA Correspondence		Ware emails comments from controlled substance staff with conclusion that lacosamide has abuse potential similar to alprazolam, a schedule IV drug
03-Jul-08		General Correspondence		Email Ware requested documents
10-Jul-08		General Correspondence		Email Ware response to multiorgan hypersensitivity issue raised in 06-JUN-2008 email, 11-JUN-2008 email, and 12-JUN-2008 teleconference

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10-Jul-08		General Correspondence		Email Sullivan to ask when to expect draft labeling from DAARP
11-Jul-08		General Correspondence		Email Ware pediatric development document
11-Jul-08	0015	Amendment to a Pending Application		Response to requests; respond to request in 11-JUN-2008 teleconference to search for cases of multi-organ hypersensitivity based on defined criteria; final part of response to 12-MAY-2008 CMC request; and Type A meeting request
12-Jul-08		Response to FDA Request for Inf		Email Ms. Ripper, FDA, table of enrollment and last subject dates in response to financial disclosure request
12-Jul-08		General Correspondence		Email Leah Ripper, FDA, table showing financial disclosure cutoff dates by trial.
14-Jul-08		FDA Correspondence		Ripper emails that financial disclosure information emailed 12-JUL-2008 addresses her concern
15-Jul-08		FDA Correspondence		Ware emails that DNP and DAARP labeling comments will likely be combined
15-Jul-08		General Correspondence		Ware emails that DAARP and DNP labeling comments will be combined
17-Jul-08	0016	Amendment to a Pending Application		Response to requests; provide case report forms related to 0015 submission
18-Jul-08		FDA Phone Contact		Teleconference to discuss multi-organ hypersensitivity and three month extension of review clock
21-Jul-08		General Correspondence		Email Ms. Ware request for copy of Eight Factor Analysis prepared by CSS to determine lacosamide's scheduling
21-Jul-08		General Correspondence		Email Ware request for copy of full Eight Factor Analysis prepared by CSS
22-Jul-08		General Correspondence		Email Ware requesting discussion on CSS analysis, potential extension of PDUFA date, clinical hold, and safety update
25-Jul-08		FDA Correspondence		Ware emails the Action letter for pain indication should be issued based on the old regulations
25-Jul-08		FDA Phone Contact		SB calls Ware to discuss additional terms for multiorgan hypersensitivity, extension of action date, CSS analysis, safety update, pediatric clinical hold, and draft label
25-Jul-08		General Correspondence		Email Sullivan to ask if Action letter for LCM for pain will be a Complete Response letter or the old style of approvable or not approvable
25-Jul-08		FDA Correspondence		Ware emails list of additional search terms suggestive or internal organ involvement
28-Jul-08		General Correspondence		Email Ware request from medical colleagues for clarity on inclusion of preferred terms hepatitis and hypersensitivity in multiorgan hypersensitivity analysis

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28-Jul-08		FDA Correspondence		Sare Stradley emails "Not Approvable" letter for 22-284
29-Jul-08		FDA Correspondence		Stradley emails that FDA will be in touch about scheduling meeting requested 29-JUL-2008
29-Jul-08		General Correspondence		Email Ware and Sullivan lifecycle 0017, response to 22-284 action letter received 28-JUL-2008, meeting request, and request for extension of review period
30-Jul-08	0017	Amendment to a Pending Applicant		Request for extension of review period; meeting request
30-Jul-08		General Correspondence		Email Ware supporting data for subject 588/8061 where the bilirubin value was normal
31-Jul-08		FDA Correspondence		Ware emails request for laboratory value criteria clarification
31-Jul-08		FDA Correspondence		Nighswander mails PDUFA extension letter for epilepsy indications
01-Aug-08		FDA Correspondence		Ware emails request from DNP's clinical team to clarify the denominators used in the search for potential multi-organ hypersensitivity
01-Aug-08	0018	Amendment to a Pending Applicant		Response to requests; provide proposed questions for Type A meeting requested 30-JUN-2008; provide location of CRF data for subject 588/806 ; submit high level pediatric development plan
04-Aug-08		FDA Phone Contact		Stradley calls to discuss meeting on Not Approvable letter for the pain indication
06-Aug-08		FDA Correspondence		Sullivan emails that 22-284 meeting request is considered a Type A meeting but usually can't be granted in requested time frame
06-Aug-08		FDA Correspondence		Ware emails comments from Controlled Substance Staff in response to 31-JUL-2008 request
07-Aug-08		General Correspondence		Email Ware clarification question on CSS analysis
11-Aug-08		General Correspondence		Email Ware requested normal lab values for subject 588/8061
14-Aug-08	0019	Amendment to a Pending Applicant		Response to requests; respond to 18-JUL2008 teleconference and 25-JUL and 31-JUL email requests for addition of search terms and criteria to multi-organ hypersensitivity search; provide normal lab values for subject 588/8061 as requested 31-JUL-2008
19-Aug-08		General Correspondence		Email Ware questions regarding meeting package to be sent for 29-SEP-2008 meeting
19-Aug-08		General Correspondence		Email Ware request for cardiac section of the draft label and question on pediatric drug development
21-Aug-08		General Correspondence		Email Ware response to 01-AUG-2008 request for multi-organ hypersensitivity information

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21-Aug-08		FDA Phone Contact		Discussion of meeting with DNP/CSS on scheduling and to discuss responses to questions previously asked
27-Aug-08	0020	Amendment to a Pending Application		Response to requests; respond to 01-AUG-2008 email request for clarification on multi-organ hypersensitivity reaction denominators; provide revised blister labels
04-Sep-08	0021	Meeting Package		Information package for Type A meeting on September 29, 2008
10-Sep-08		General Correspondence		Email Ware that response to multi-organ hypersensitivity request was sent as life Cycle 19 on 14 AUG-2008
23-Sep-08	0022	Amendment to a Pending Application		Meeting Package for Type A meeting on October 16, 2008
26-Sep-08		General Correspondence		Email Sullivan letter from Schwarz to EMEA withdrawing the lacosamide pain application
26-Sep-08		FDA Correspondence		Ware emails Agency's preliminary responses to questions for 29-SEP-2008 meeting
29-Sep-08		FDA Correspondence		Sullivan emails that 15 desk copies will be required for 16-OCT-2008 meeting package
30-Sep-08		General Correspondence		Email Sullivan that meeting package for 16-OCT-2008 meeting will be sent via email today and as a lifecycle tomorrow, 01-OCT-2008
01-Oct-08		FDA Correspondence		Sullivan emails thanks for PDF of 16-OCT-2008 meeting package and provides mailing address for desk copies
03-Oct-08		FDA Correspondence		Ware emails list of FDA attendees from 29-SEP-2008 meeting
08-Oct-08		General Correspondence		Email Ware meeting minutes and meeting slides from 29-SEP-2008 meeting with DNP and CSS
10-Oct-08		General Correspondence		Email Ware letter from Patty Fritz requesting teleconference to discuss scheduling
14-Oct-08		FDA Correspondence		Dr. Throckmorton emails to notify that Agency is discussing how best to handle teleconference requested 10-OCT-2008
15-Oct-08	0023	Amendment to a Pending Application		Reply to FDA preliminary response to questions submitted in life cycle 0021 concerning CSS recommendations of C-IV scheduling
15-Oct-08	0023	Amendment to a Pending Application		Reply to FDA preliminary response to questions submitted in life cycle 0021 concerning CSS recommendations of C-IV scheduling
17-Oct-08		General Correspondence		Email Ware proposed REMS form
21-Oct-08		FDA Phone Contact		Ware returned call to discuss issues from label review, including storage conditions, safety pharmacology section, CSS class, suicidality, and post-marketing commitments

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21-Oct-08	0024	Amendment to a Pending Applicat		Proposed REMS
21-Oct-08	0024	Amendment to a Pending Applicat		Proposed REMS
23-Oct-08		FDA Correspondence		Ware emails post-marketing commitments and labeling revisions
23-Oct-08		General Correspondence		Email Ware response to Division label changes and proposals for consideration as well as a justification document for the sponsor-requested changes
27-Oct-08		General Correspondence		Email Ware analysis requested at 27-OCT-2008 meeting for PR outliers
29-Oct-08		FDA Correspondence		Ware emails complete response letter for 22-255 and approval letter for 22-253 and 22-254
30-Oct-08	0025	Amendment to a Pending Applicat	SP903	Response to request; additional information requested in 20-OCT-2008 teleconference by Dr. Throckmorton from SP903, abuse liability trial
30-Oct-08	0025	Amendment to a Pending Applicat	SP903	Response to request; additional information requested in 20-OCT-2008 teleconference by Dr. Throckmorton from SP903, abuse liability trial